FOODS AND THEIR ADULTERATION

WILEY

From "Science," New York:

Seldom has a more timely book appeared than this, following so closely as it does the beginning of the enforcement of the new national pure-food law. For some time prior to the passage of this law public interest throughout the country had become vitally awakened to the importance of the pure-food issue. Amid a large mass of confusing and often exaggerated newspaper articles dealing with the subject, it is a comfort to find a book covering the field so completely, so sanely and withal in so interesting a way.

While the manual, by the author's statement, is not especially designed for the expert chemist, and chemical terms are carefully explained for the benefit of the public, yet the food analyst will need the book on his shelves for reference. From the chemist's standpoint, the many tables and results showing the composition of the various food products are especially useful for comparison. In many cases also are given some of the latter and more improved tests for adulteration, which in some instances have not hitherto been so readily available.

The book treats systematically and quite exhaustively of all the principal food products, dealing in turn with their manufacture, properties and composition, forms of adulteration and dietetic value, and including much information of a general nature concerning them. Beginning with the animal foods, it thus covers meats and the various meat preparations, fish, milk and its products and oleomargarine. Then follow the vegetable foods, cereals, vegetables proper, condiments, fruits, sugar, syrup, confectionery, honey, and finally infants' and invalids' foods. * * *

Though destined for a wide variety of readers, the book is apparently designed first of all for the benefit of the public, at a time when the public wants particularly to know about its food; and written as it is from a strictly scientific standpoint, yet in a popular way, by one who from long experience knows so thoroughly his subject, it will be widely read and to great advantage by the people as consumers.

Not only does the author cover the ground directly suggested by the title, but in a general and useful way gives throughout much information about food values and the use of food for bodily nourishment. The colored plates illustrating the appearance of cuts of healthy beef, for example, will be found especially helpful to the householder.

To the food manufacturer and dealer the book is almost indispensable, since it describes very plainly the methods of preparation and standards of purity, the effects of storage, and, in addition, gives much good and sound advice regarding what might be termed controversial forms of adulteration, such as chemical preservatives and artificial coloring, called controversial because their use with restricted labels has to some extent been legalized under some of the state laws, and because they have for years formed the subject of much difference of opinion among experts in food litigation. * * *

FOODS AND THEIR ADULTERATION

ORIGIN, MANUFACTURE, AND COMPOSITION OF FOOD PRODUCTS; INFANTS' AND INVALIDS' FOODS; DETECTION OF COMMON ADULTERATIONS

BY

HARVEY W. WILEY, M.D., PH.D.

WITH ELEVEN COLORED PLATES AND EIGHTY-SEVEN OTHER ILLUSTRATIONS

Third Edition

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PREFACE TO THE THIRD EDITION.

In presenting the Third Edition of Foods and Their Adulteration the author desires to express his satisfaction that the book has had so large and so continuous a sale. It is, therefore, important that the whole body of the book be brought up to date to include the many new food products which have been introduced since the First and Second Editions were published. Also important principles in the use of foods have been discovered since the book first went to press, and these should also be incorporated. The re-writing of the book to include all the new articles of diet is necessarily postponed for the present. The Third Edition, therefore, will contain simply the new matters relating to the new principles that have been discovered in the use of foods. These are important discoveries both in relation to food economy and, especially, in relation to health and vigor. The original standards, established by authority of Congress in the Department of Agriculture, have been very greatly changed during the last five years, so that the condition of the standards is now somewhat chaotic. Until some order and arrangement be introduced into the standards, so that they may be regarded as practically permanent, it has been thought best to omit the original standards and not to try to incorporate the new ones until they have been completed and established. Little or no benefit has come from the making over of the standards. It has been, in the opinion of the author, a work of supererrogation, the changes not being worth the trouble and labor which they have required. Also the propriety of replacing standards specifically authorized by Congress by new ones not specifically authorized is a matter of considerable legal importance. For these reasons the space occupied by these standards in previous editions has been given to more important subjects.

HARVEY W. WILEY

WASHINGTON, D. C.

PREFACE TO THE SECOND EDITION.

The text of the body of this work has been carefully revised and the statistical matter brought up to date. Many of the paragraphs have been entirely re-written, but in general the text and the sequence of the articles remain as in the first edition. Two new parts of importance have been added to the volume, taking the place of the regulations for inspection and the rules and regulations for the enforcement of the Food and Drugs Act, which are now of such wide distribution as to need no place in this work.

The space so saved by the exclusion of these appendices has been given to an expansion of the article on infants' and invalids' foods and to a new part devoted to simple tests for ordinary adulterations which may be practiced with some degree of success in the household.

In the section devoted to infants' and invalids' foods an attempt has been made to describe in a practical way the preparation and care of foods of this class, accentuating meanwhile the supreme importance of the natural supply of milk for infants under the age of one year, or where this is denied the substitution of wholesome, fresh cow's milk, modified to resemble, as nearly as possible, the natural sustenance of the infant. The composition of some of the principal substitutes for the natural foods of infants has been given with a note of warning as to the danger of the employment of even the best of these foods to the exclusion of nature's natural food supply.

This article has been written with no spirit of antagonism towards the prepared foods for infants, but only to bring promptly before the mind of the lay reader, as pointedly as possible, the supreme importance of using the natural food even when an artificial preparation resembles it as nearly as can be.

The article on invalids' foods has been written in the light of recent medical studies, which show that wholesome food is not only the best prophylactic but also in many cases, especially of chronic diseases, the best remedy at the service of the physician. Proper nutrition is extremely effective in preventing some forms of disease, and proper feeding, based on scientific principles, the most effective remedy.

In the treatment of this subject care has been taken to avoid the danger into which so many writers fall of uttering dicta regarding nutrition which are founded rather on misinformation than on the solid basis of truth. While the science of scientific feeding, as a remedy of disease, is still in its infancy it is hoped that the present contribution may do much to enlighten the mind of the lay public on a question of such great importance as the treatment of disease in the home.

With the household tests for simple adulterations an intelligent housewife with a little practice may be able to inform herself of the most commonly occurring adulterations. Especially is this true if there be supplied, at the same time, a series of samples of the genuine products which may be submitted to the proposed tests. In this case the difference in reaction obtained between the genuine and adulterated articles becomes the more evident.

All the appendices have been removed from the revised edition saving the standards of purity of food products adopted by the Secretary of Agriculture, in harmony with the provisions made by Congress.

HARVEY W. WILEY.

WASHINGTON, D. C.

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INTRODUCTION.

THE growing importance to manufacturers, dealers, and consumers of a knowledge of food products has led to the preparation of the following manual.

Unfortunately, many misleading statements respecting the composition of foods, their nutritive value, and their relation to health and digestion have been published and received with more or less credence by the public. Claims of superior excellence, which are entirely baseless, are constantly made for certain food products in order to call the attention of the public more directly to their value and, unfortunately, at times to mislead the public with respect to their true worth.

It is not uncommon to see foods advertised as of exceptional quality, either as a whole or for certain purposes. Many of the preparations of this kind are of undoubted excellence, but fail to reach the superior standard or perform the particular function which is attributed to them. Particularly has it been noticed that foods are offered for specific purposes or the nourishment of certain parts of the body, especially of the brain and nerves. We are all familiar with the advertisements of foods to feed the brain, or feed the nerves, or feed the skin. It is hardly necessary to call attention to the absurdity of claims of this kind. One part of the body cannot be nourished if the other parts are neglected, and the true principle of nutrition requires a uniform and equal development and nourishment of all the tissues. It is true that many of the tissues have predominant constituents. For instance in the bones are found large quantities of phosphate of calcium and in the muscles nitrogenous tissues dominate. In the brain and nerves there are considerable quantities of organic phosphorus. All of these bodies, however, are contained in normal food properly balanced.

It would be contrary to the principles of physiology to attempt to feed the bones by consuming a large excess of phosphorus in the food or the muscles by confining the food to a purely nitrogenous component. Such attempts, instead of nourishing the tissues indicated, will so unbalance the rations as to disarrange the whole metabolic process, and thus injure and weaken the very tissues they are designed to support.

It seems, therefore, advisable to prepare a manual which may be used in conjunction with works on dietetics and on physiology and hygiene and yet of a character not especially designed for the expert.

The American public is now so well educated that any average citizen is fully capable of understanding scientific problems if presented to him in a non-technical garb.

It is, therefore, not difficult to see that the great army of manufacturers and dealers in food products, as well as the still greater army of consumers, are able to receive and to utilize information concerning food products which is of common interest to all. A dissemination of knowledge of this kind will guide the manufacturer in his legitimate business and protect the public against deceptions such as those mentioned above.

In the evolution of society, economy and efficiency indicate that specializations should be made as completely as possible. For this reason it is advisable that foods of a certain character be manufactured and prepared for consumption on a large scale, so that due economy and purity may be secured. On the other hand there are many other kinds of foods which, by reason of their properties, cannot be prepared on a large scale but must be produced near or at the place of consumption. Milk is a type of this class of foods. It is altogether probable, therefore, that the consumption of manufactured foods will not decrease but increase even more rapidly than the number of our population.

In order that the people may be able to judge of the quality and character of products of this kind, information readily available appears to be highly desirable.

In the other case of the utilization of raw materials, it is equally important that the people of this country understand their nature and their functions in the digestive process. The great nutritive value of our food is found in the cereals, the meats, the fruits, and vegetables which we consume. A description of foods of this class, the places of their growth, the conditions under which they are matured and marketed, the problems which relate to their storage and transportation, their composition in respect of nutrition and digestibility, the dangers which may accrue from their decay, and the adulterations or sophistications to which they may be subjected are matters of the greatest public importance.

A treatise of this kind in order to be of its full value for which it is intended must be concise, expressed in simple language, in a form easily consulted, and yet be of a character which will be reliable and which will give full information on the subject.

It is a common habit of speech to divide foods into two great classes, namely, foods and beverages. This is not a scientific division, but is one which has been so well established by custom as to render it advisable to divide this work into two portions, one devoted to food in the sense just used and the other to beverages. The first volume of this work devoted to foods will treat of those bodies commonly known under the term "foods,"—namely, cereals, meats of all kinds, milk, vegetables, nuts, and fruits. The second volume will embrace the study of beverages, namely, natural and artificial mineral waters, soda waters, soft drinks, coffee, tea, cocoa, wines, cider, beer and other fermented beverages, distilled beverages of all kinds, and mixtures or compounds thereof.

In connection with the description of the origin of foods and their general characteristics will be given a statement of their chemical composition, especially in relation to nutritive properties. The principal adulterations or sophistications to which the food products are obnoxious will be briefly described, and where simple methods of detecting adulterations are known, of a character to be applied without special chemical knowledge or skill, they will be given.

An attempt is thus made to lay before those interested, in as compact a form as possible, the chief points connected with the production of food, its manipulation, and its use for the nourishment of the body.

It is not the intention of this manual to enter at all into the subject of cooking or the physiology of foods and nutrition. That is a distinct and separate part of this problem and has already been treated in many manuals. In this connection, however, attention may be called to the great importance of proper cooking in the use of food. Raw materials of the best character, prepared and transported in the most approved manner, may be so injured in the kitchen in the process of cooking as to be rendered both unpalatable and difficult of digestion. On the contrary, food materials of an inferior quality, provided they contain no injurious substances, may be so treated by the skilled cook as to be both palatable and nutritious. The desirability of the dissemination of correct principles of cooking is no less than that of giving information respecting the materials on which the art of cookery is exercised. It may be added that the art of cookery at the present time should not be confined to the mere technical manipulation, the application of heat and of condimental substances, but should also have some reference to the actual process of nutrition.

Foods should be prepared in the kitchen, not only of a palatable character and properly spiced but also selected in such a manner as to safeguard one of the chief purposes of food, namely, the proper nutrition of the body and the avoidance of any injury to digestion.

It is commonly admitted that many, perhaps most, of the diseases of the digestive tract to which the American people are so subject arise from the consumption of rations improperly balanced, poorly prepared, or used in great excess. To the intelligent and scientific cook the information contained in this manual will especially appeal.

A PROPER RATION.

The study of the science of nutrition has revealed the character of nourishment necessary to build the tissues and restore their waste. The term "food" in its broadest signification includes all those substances which when taken into the body build tissues, restore waste, furnish heat and energy, and provide appropriate condiments. The building of tissues is especially an important function during the early life of animals as it is through this building of tissues that growth takes place. The restoration of waste of tissues assumes special importance during that period of life when the weight of the body is supposed to be reasonably constant. At this time the waste of tissue in the natural processes is restored by the assimilation of new material in the same proportion.

If the assimilation of new material goes on at a greater rate than the waste of old material it manifests itself during the period of expected equilibrium in the deposition of adipose tissue and a consequent abnormal increase in weight.

In the after period of life the process of waste is naturally more vigorous than that of assimilation, and the tendency is manifested, which is wholly in harmony with the laws of Nature, to gradually diminish the weight of the body, and this continues to the extreme emaciation of old age.

It is evident, therefore, that the food consumed should be adapted to these changing periods. The growing animal needs a larger quantity of food in proportion to its actual weight than the animal which is in a state of equilibrium, that is, of mature age, and the animal which is entering upon the period of old age needs a less quantity of food in proportion to its weight than in either of the other periods of life. Thus, the rations of infants and children should be generous, the rations of mature man sufficient, and the rations of old age limited.

The food should also contain the various elements which enter into nutrition in the proper quantity. The nitrogenous constituents in food, when subjected to the ordinary process of digestion, yield a certain quantity of heat and energy but their more important function is to nourish the nitrogenous elements of the body, of which the muscles, hair, skin, and fingernails are types. The mineral constituents of food, especially phosphorus and lime, have a general utility in promoting the metabolic functions, especially in the movement of the fluids of the body through the cells walls, and at the same time are actual nourishing materials, entering particularly into the composition of the bones and teeth.

The fats and oils which are present in the foods have the capacity of producing large quantities of heat and energy during their combustion in the body, and thus serve as a source of animal heat and muscular activity.

The starches and sugars which are the most abundant elements of our food, although they have a heat-forming power of less than one-half that of fats, are largely utilized in the production of heat and energy and in the formation of animal fat.

To secure a proper and complete nutrition of the body it is desirable that all these elements should be so adjusted as to provide for complete nourishment without having any one of them in great excess. It is evident that an excess of any one or more of these nutrient materials must necessarily impose on the organs of the body an additional work in securing their proper elimination. This tends to overburden the excretory organs and to cause a premature breakdown thereof. This giving away of the organs may not come for many years, not, perhaps, until advanced life, but when it comes it necessarily shortens the period of human existence.

The term "**balanced ration**" means the adjustment of nutrients in the food in such a way as to secure complete and perfect nutrition without loading the body with an excess of any one element. This is also an important point on the score of economy. A large percentage of all the earnings of man is expended for food products, and hence these products should be used in a manner to secure the best results possible. If, by a practice of scientific nutrition, 10 percent of the value of foods could be saved it would create a fund which, could it be utilized, would minister in the highest degree to the comfort and welfare of the human family and form an abundant pension for old age.

SOCIAL FUNCTIONS OF FOOD.

In the above paragraphs attention has been directed particularly to the nutritive and economic properties of food. It must not be considered that mere nutrition is the sole object of foods, especially for man. It is the first object to be conserved in the feeding of domesticated animals, but is only one of the objects to be kept in view in the feeding of man. Man is a social animal and, from the earliest period of his history, food has exercised a most important function in his social life. Hence in the study of food and of its uses a failure to consider this factor would be regrettable. For this reason it is justifiable in the feeding of man to expend upon the mere social features of the meal a sum which often is equal to or greater than that expended for the mere purpose of nutrition. This part of the subject, however, belongs especially to the kitchen and dining room, and, therefore, will not be discussed at greater length at the present time.

It is believed that a more careful study of the food he consumes will benefit man in many ways. It will lead to a wider public interest in the problem of the purity of food and the magnitude of the crime committed against mankind in the debasement, adulteration, and sophistication of food articles.

This study will impart to the social function of food an additional charm, in that the origin and character of the material consumed will be known and the properties which they possess for nourishing the body understood. This will enable man, as a social animal, to so conduct himself at table as to secure the greatest possible pleasure and social benefit therefrom and at the same time avoid any injury which ignorance might permit and invite.

It may appear that the inartistic treatment of a subject of this kind, as indicated in the following pages, is not one which is calculated to excite any sympathetic interest or appeal to the natural desire for literary and artistic expression. Yet the importance of the subject is so great as to warrant the experiment of presenting the matter in this form rather than in any more elaborate and connected way.

DEFINITION AND COMPOSITION OF FOODS.

Food, in its general sense, is that which nourishes the body without regard to its physical state, that is, it may be solid, liquid, or gaseous. More particularly defined, food is that material taken into the body in the ordinary process of eating which contains the elements necessary for the growth of tissues, for the repair of the destruction to which the tissues are subjected during the ordinary vital processes and for furnishing heat and energy necessary to life. Incident to the utilization of these elements there is consumed, also, a considerable quantity of matter inextricably mingled with food in a natural way, which takes no direct part in nutrition and yet which is useful, as a mass, in promoting the digestive processes. These bodies are certain indigestible cellular tissues which are present in foods, mineral matter, and other materials which are naturally found in food products. Included in this broad definition, therefore, are many substances which are usually not thought of in the sense of food; among these are water and air. Air, however, would probably be excluded because it is not introduced into the stomach, that is, not in quantities which have any significance in the vital processes. Water, on the contrary, is one of the most indispensable constituents of food and is also used in considerable quantities as a beverage. The water, itself, is indispensable to nutrition and is also one of those bodies mentioned above which are necessary to secure the proper conduct of the digestive processes.

By means of the oxygen in the air the combustion of food in the various parts of the body is secured, and thus animal heat and energy developed. In this respect the combustion of a food product is similar in every way to the burning of coal in the production of heat and motion. The same calorific laws which govern the steam-engine are applicable, in all their rigidity, to the animal engine. The quantity of heat produced by the combustion of a certain amount of fat or sugar is definitely measured in a calorimeter and is found to correspond exactly to the quantity of heat produced by the ordinary combustion of such bodies. The term "food," therefore, in this respect, would include the oxygen of the air without which the development of animal heat and energy would be impossible. It also includes those bodies of a liquid character which are classed as beverages rather than as foods. All of these bodies have nutritive properties, although their chief value is condimental and social.

That large class of food products which are known as condiments are properly termed food, since they not only possess nutritive properties but through their condimental character promote digestion and by making the food more palatable secure to a higher degree the excellence of its social function.

It is now possible to condense into a distinct expression the definition of food in the following language: Food in a general sense embraces those substances taken into the body which build tissues, restore waste, and furnish heat and energy.

CLASSIFICATION OF FOODS.

Foods may be considered under different classifications. First, as to general appearance and use three classes may be made,—foods, beverages and condiments. As types of the first division of these foods may be mentioned cereals and their preparations, meat and its preparations (except meat extracts), fish, fowl, and game. Beverages are those liquid food products which are more valued for taste and flavor than for actual nutritive value. As types of beverages may be mentioned wines, beers, distilled spirits and liquors of all characters, tea, coffee, cocoa, chocolate, etc. Under wines, in this sense, may be included the fermented beverages made of fruit juices, such as cider, perry, etc. Types of condiments are salt, pepper, spices, vinegar, etc. Milk, although a liquid substance, is hardly to be considered a beverage, and on account of its high nutritive properties may be classed, together with its preparations, under the first head.

Foods may also be classified as nitrogenous, starchy, oily, and condimental. Nitrogenous foods are those in which the proportion of their material containing nitrogen is large. Lean meat may be regarded as a type of nitrogenous food, since it consists almost exclusively of tissues known as protein and contains nitrogen and sulfur as essential ingredients. The white of an egg is also a typical nitrogenous food and, to a less extent, the yolk. Among vegetables, peas and beans are typical foods containing large percentages of nitrogenous matter. The gluten of wheat is also a typical nitrogenous food and the zein of Indian corn, corresponding to gluten, is a nitrogenous material.

Practically all the vegetables used as foods contain more or less protein in their constituents. Among the cereals oats has the largest quantity and rice the smallest of this valuable food material. Of oily foods the fat of animals, including butter, is a typical representative. All meats, fish, fowl, and game contain more or less fat. Of vegetables and fruits there are many which contain large quantities of fat, such as nuts, oily seeds, etc. All vegetables contain more or less fat, although the succulent vegetables usually contain but little thereof. Of starchy foods there are no types in animal food, the quantity of carbohydrate material therein being extremely limited. The lobster and horse-flesh contain perhaps a little more than 1 percent of carbohydrate food, but most meats contain much less than that. Sugar and starch are typical carbohydrate foods.

The cereal grains are composed largely of starchy foods, and so are certain tubers, such as the potato, cassava, etc. Of the common cereals rice contains more starch than any other and oats the least. Sugars are intimately related to starch and are included under the term starchy food or carbohydrate food. The carbohydrate matter in the flesh mentioned above, namely glycogen, is of the nature of a sugar. Among the typical sugar foods are beets, melons, and fruits, some of which contain large percentages of sugar. All fruits contain greater or less quantities of sugar, and that is true, also, of all vegetables.

Of the plants which produce the sugar of commerce there may be mentioned the sugar-cane, the sugar-beet, the maple, and palm trees. The principal sources of the sugar of commerce are the sugar-cane and the sugar-beet.

Of the condimental foods may be mentioned spices, including pepper, mustard, cinnamon, allspice, and other foods of this class. Common salt occupies a unique position in food products. It is the only mineral substance which has any value as a condiment in human food. But it also has a more important function than its condimental character, namely, it furnishes the supply of hydrochloric acid without which digestion in the stomach could not take place. For this reason common salt must be regarded as an essential food product as well as a condiment.

EXPLANATION OF CHEMICAL TERMS.

Inasmuch as this manual is not solely intended for expert chemists and physiologists but also for the general public, a simple explanation of the use of the terms used in analytical data and tables is advisable.

Under the term **moisture** is included all the water which is present in a free state, that is, not combined in any way with the ingredients of the material, and other substances volatile at the temperature of drying. The water is determined by drying to a constant weight at the temperature of boiling water or slightly above. In bodies which are easily oxidized this drying takes place in a vacuum or in an inert gas like hydrogen or carbon dioxid.

Protein.—Under this term are included all the nitrogenous compounds in a food product which contain in their composition sulfur, nitrogen, carbon, hydrogen, and oxygen, forming that class of tissues represented by the gluten in wheat, the white of an egg, muscular and tendinous fibers, etc.

Ether Extract.—Under this term is included the fats and oils, the term fat being applied to animal fat and the term oil to vegetable products. These bodies are all soluble in ether and therefore are grouped together under the term "ether extract." There are some fats both in animal and vegetable substances insoluble in ether, but they exist in minute quantities and therefore are not separated from the extracts, but the whole matter is given together and represents practically the fats and oils in food.

There are also minute quantities of bodies not fats in foods soluble in ether, and these are included in the ether extract.

Ash.—The term ash is applied to the residue left after the burning of food products in the air at a low temperature until the carbon has disappeared. Ash is rather an indefinite term and is applied to that residual material of a mineral nature composed of sand or silica and the carbonates or oxids of alkaline earth or alkalies. The ash also contains the principal part of phosphorus present in food products and usually a small proportion of sulfur. These bodies in the ash exist as phosphoric and sulfuric acids or their salts.

Fiber.—The term fiber is applied to those carbohydrate products in food which are insoluble in solutions of dilute acid and dilute alkalies at the boiling temperature. Inasmuch as these separated bodies are not wholly pure cellulose they are often designated as crude fiber.

Starch and Sugar.—The terms starch and sugar are applied to the carbohydrates in a food product of a starchy or saccharine nature, together with the other carbohydrates present which are soluble in dilute acids and alkalies.

Calories.—The term calorie is used to denote the amount of heat-forming material contained in one unit weight of a food product. The number given represents the number of degrees of temperature produced in a unit mass of water by the heat formed in burning the unit weight of food. The unit weights employed are usually as follows: Of the food product, one gram (15 grains); unit weight of water to be heated, one kilogram (2.2 pounds); unit increment of temperature, 1° C. (1.8° F.). The expression 4000 calories therefore means that if one gram of food substance in a dry state be burned the heat produced will raise one gram of water through a temperature of 4000° C., or the unit of water (one kilogram) through a temperature of 4° C. For convenience the calories are usually expressed as small calories, namely 4000, instead of large calories, namely 4. In this manual the expression in terms of small calories, that is, the temperature increase of one kilogram of water produced by burning one gram of substance, multiplied by 1000, will be uniformly employed.

FOODS

AND THEIR

ADULTERATION.

PART I.

MEATS.

One great division of human food is meat. Technically, perhaps, the edible flesh of every animal used for human food might be described as meat. In this manual, however, preference is given to the common meaning of the term.

The flesh of animals is by common consent divided into three principal classes, namely, the flesh of terrestrial mammals, or animals not provided with wings; second, aerial animals, or animals provided with wings, and, third, aquatic animals. A very common classification of these three kinds of food is flesh, fowl, and fish. There are animals, the flesh of which is eaten by many, which are not exactly included in this classification; for instance, animals of an amphibious nature, living partly on land and partly on sea. Also many of the animals classed as aerial live chiefly upon the earth; although having wings they do not use them, such as domesticated fowls. This classification, however, is sufficiently exact for the practical purposes of a food manual and, therefore, under the head of meat is included the edible flesh of mammals living on the land.

Animals Whose Flesh is Edible.—Probably the only complete classification of this kind would be to include every animal living on the face of the earth since, perhaps, the flesh of every animal living has been more or less eaten by man. In a civilized community, however, except in times of disaster and dire necessity, certain classes of animals only furnish the principal meat food. Nearly all the meat food consumed in the United States is derived from cattle, sheep, and swine. Goat flesh is eaten only to a limited extent and horse meat scarcely at all, and the only other meats of importance are those of wild animals. The principal wild animals used for food are the deer, bear, rabbit, and squirrel. Many other wild animals, however, are eaten and in some cases highly prized. In this manual only the principal meat foods both of domesticated and wild animals will be mentioned.

Classification of Meat Food as Respects Age.—The edible flesh of domesticated animals as well as of wild animals is eaten both in the young and full-grown state. Common names, however, designate these different classes. For instance, veal in the growing and beef for the full-grown animal, lamb for the young and mutton for the full-grown sheep, pig in the younger and pork in the full-grown swine, etc. There is no legal limit of age for such a distinction, but as long as the animal is not fully grown it may be classified under the name representing the young animal. There is a common understanding, however, that in the case of veal and lamb the animal must be under one year of age and usually not under two nor more than eight months of age. A classification of this kind is so indefinite, however, that no strict definition can be given other than that founded on the general principles above outlined.

Preparation of Animals.—The proper sanitary conditions attending the fattening of animals intended for slaughter are of great importance to the consumer. It is a common understanding that animals intended for slaughter should be plump and healthy. Poor animals, either those which are meager from lack of food or from disease, are to be rigidly excluded from the slaughter pen. Animals intended for slaughter should be fattened under sanitary conditions with plenty of fresh water and fresh air as well as good food. The stalls in which they are fattened should be clean and well ventilated, and the sanitary conditions surrounding them should be such as to exclude contagious and epidemic diseases and provide the most favorable environment for growth and preparation for the market.

It is evident that all these conditions are to be secured by proper inspection of the animals while preparing for the market. The time will, doubtless, soon arrive in this country when the supervision of the preparation of animals for the market, the sanitary conditions under which they live, and the general environment which surrounds them shall be subjects of local, municipal, and state inspection. Since the power of the general government cannot extend to states and municipalities, these corporate bodies should take uniform and scientific action concerning all these matters. National and state conventions of municipal and state sanitary authorities should decide upon uniform systems of inspection and sanitation to which all state and municipal authorities must agree, so that a uniform and effective method of inspection and sanitation will be secured throughout the country.

When animals are transported before slaughter from one state to another the national government is then entitled to inspect and certify respecting th condition of the animal thus to be transported from state to state. By thus combining municipal, state, and national inspection the rights of the consumer may be conserved, and this is the only means by which they can be kept inviolate.

It is assumed, therefore, that the animal which has been brought for slaughter has been fattened under proper sanitary conditions, has not been exposed to epidemic or contagious diseases, and outwardly is not afflicted with any disease of its own. Such a healthy animal may then be certified as fattened for slaughter.

Inspection after Slaughter.—The inspection after slaughter is of the utmost importance, not even second to that of the proper inspection during fattening and before slaughter. The veterinarian, skilled in his science, can tell by the inspection of the vital organs of the slaughtered animal whether it is affected with any organic disease. Among cattle the most frequent organic diseases are lumpy jaw and tuberculosis. In the case of swine one of the most common of diseases is trichinosis. In the latter case an inspection of the vital organs of the animal is not sufficient. The muscles of the swine, first and most commonly affected by trichinosis, must be examined microscopically in order to eliminate the possibility of the flesh of such animals going into commerce untagged or unnoticed.

If the flesh of the swine impregnated with trichinosis be thoroughly cooked practically all of the danger to man is eliminated. The consumer, however, should not be subjected to the chance of imperfect cooking. A swine affected with trichinosis should either be refused admission into consumption or should be so tagged that the consumer should know the danger to which he is exposed in order to take the necessary precaution to safeguard his health.

Tuberculosis.—There is a difference of opinion among veterinary and hygienic experts respecting the disposition which is to be made of carcasses affected with tuberculosis. It is claimed by some that if the tuberculosis is local, that is, does not extend beyond the lungs, there is no reason why the flesh of the animal should be refused to the consumer. The basis of this contention is founded upon the opinion of some of the most eminent veterinarians that bovine tuberculosis and human tuberculosis are entirely distinct diseases and cannot be transmitted either from the cow to man or *vice versâ*. It is not the province of this manual to decide this controversy, although it is only right that the consumer should be given the benefit of the doubt. Therefore, if the carcass of an animal affected with local tuberculosis is to be passed into consumption it should be plainly marked as the flesh of a tuberculosed animal,—not only the carcass as a whole, but every piece thereof that is introduced into consumption directly or after canning or mincing. The consumer is thus left free to choose for himself whether to eat such meat or not. There is a universal agreement among hygienists and veterinarians that where tuberculosis is generalized, that is, has affected practically all the organs of the body, the carcasses should be condemned. No one will take exceptions to this ruling, though it does not appear very plain to the ordinary consumer why a little tuberculosis is not a bad thing if a great deal of it is a very bad thing. There is an unfortunate tendency in many quarters to neglect minute effects and only pay attention to mass action. This does not seem to be a reasonable or desirable method of procedure.

The Right of the Consumer.—In all these cases of post mortem inspection it is the right of the consumer to be informed respecting the condition of the animal admitted to slaughter. Only the undoubtedly sound and healthy carcass should be given a free certificate. The badly diseased carcass should be condemned and refused admission to consumption. If the partially diseased carcass is to be consumed, it should be done under such a system of tagging as will absolutely protect any consumer against the use of the partially diseased carcass without his knowledge.

Summary.—The general conclusion reached is that the consumer has the right to protection in the character of food which comes upon his table. This protection begins at the time the animals are being fed for slaughter. It continues during the time the animals are slaughtered and afterwards in the preparation of their carcasses for consumption. It does not end until the meat is delivered to the consumer properly certified as being sound and wholesome and warranted to be free from deleterious coloring matter and preservatives. The consumers of this country can have this protection if they demand it. They outnumber the makers of meat products to such an overwhelming extent as to be able to secure proper legislation, because the manufacturers themselves, as consumers, are equally interested with others in this most important point, and should themselves receive for their families the same protection that the consumer who has nothing to do with the preparation of meat products is entitled to.

Since the above paragraph was written the Congress has provided for a complete inspection of meats as outlined therein.

Slaughter and Preparation of Carcasses.—It is not the purpose of this manual to enter into any discussion of the technique of slaughter and preparation of animals whose meat is intended to be eaten. It is believed that in this country the mechanism of this process is very near perfection, and especially so in the larger establishments where the highest skill is employed. In small slaughtering establishments and in farm slaughter there are found many points of technique which should be greatly improved. The principal thing to be considered is, first, a sudden and in so far as possible a painless death of the animal; second, the immediate withdrawal of the blood of the slaughtered animal if slaughtered otherwise than by opening the principal artery; third, the removal of the intestines and hair or hide of the animal; fourth, immediate

Natural Appearance of Cuts of Healthy Beef

Beef is the most important of any of the meat of flesh foods. To be able to judge of its freshness and freedom from disease is of great practical value. The following colored plates show the appearance of some of the principal cuts of beef in the proper condition for cooking. By comparing the appearance of the beef bought in all markets with these plates it is possible to form a sound judgment of their suitability for consumption.

These seven Plates are reproduced by courtesy of Armour & Co., Chicago

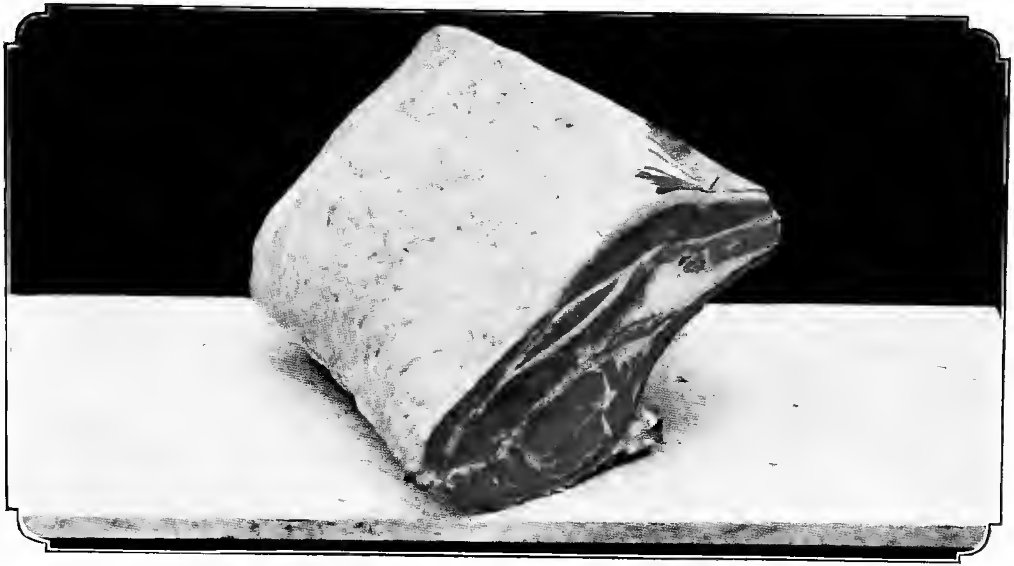
Beef Tenderloin

Beef Sirloin

Beef Ribs—Regular Cuts

Beef Ribs—Spencer Cut

Sirloin Butts



Beef Rib

Beef Loin

cooling at a moderately low temperature until the animal heat is entirely radiated; fifth, the cutting of the carcass into the usual form for consumption and the removal and utilization of the débris for food or other purposes; sixth, the delivery of the meat, if to be eaten in a fresh state, in a condition secured from contamination and decay until it is in the hands of the consumer; seventh, the curing of the meat in a proper manner by salt, sugar, vinegar, and wood smoke, and the delivery thereof in an uncontaminated form to the consumer.

It is not established that any further manipulation than that above outlined is desirable or necessary. The use of any kind of dye or coloring matter directly or indirectly, of any so-called preservative substance other than those of a condimental nature already mentioned, or any further manipulation save that to secure low temperature and freedom from infection is not useful, necessary, nor desirable. The sooner the manufacturer of these products understands the rights of the consumer in this respect and recognizes the fundamental verity of the above postulates the better it will be for all parties. When these conditions are met all of the many and just objections which have been made to the meats of this country will pass away and they will assume in the markets of the world that position to which their natural merits, when not interfered with by maltreating during curing, entitle them.

Names Applied to the Different Pieces of Edible Animals.—In the preparation of animals for the market experience has shown that they are best cut in certain pieces of a shape determined by the race of the animal itself and to these pieces or cuts certain definite names have been applied. The method of making these cuts is not the same in all parts of this country or in various parts of different countries. The most common cuts used in the United States are illustrated in the accompanying figures, under the names which are attached thereto.

The analyses here reported apply to cuts as indicated by the following diagrams. These show the positions of the different cuts, both in the live animal and in the dressed carcass as found in the markets. The lines of division between the different cuts will vary slightly, according to the usage of the local market, even where the general method of cutting is as here indicated. The names of the same cuts likewise vary in different parts of the country.

The Cuts of Beef.—The general method of cutting up a side of beef is illustrated in Fig. 1, which shows the relative position of the cuts in the animal and in a dressed side. The neck piece is frequently cut so as to include more of the chuck than is represented by the diagram. The shoulder clod is usually cut without bone, while the shoulder (not indicated in diagram) would include more or less of the shoulder blade and of the upper end of the fore shank. Shoulder steak is cut from the chuck. In many localities the plate is made to include all the parts of the fore quarter designated on the diagrams as brisket, cross ribs, plate, and navel, and different portions of the plate, as thus cut, are spoken of as the "brisket end of plate" and "navel end of plate." This part of the animal is largely used for corning. The ribs are frequently divided into first, second, and third cuts, the latter lying nearest the chuck and being slightly less desirable than the former. The chuck is sometimes subdivided in a similar manner, the third cut of the chuck being nearest the neck. The names applied to different portions of the loin vary considerably in different localities. The part nearest the ribs is frequently called "small end of loin" or "short steak." The other end of the loin is called "hip sirloin" or "sirloin." Between the short and the sirloin is a portion quite generally called the "tenderloin," for the reason that the real tenderloin, the very tender

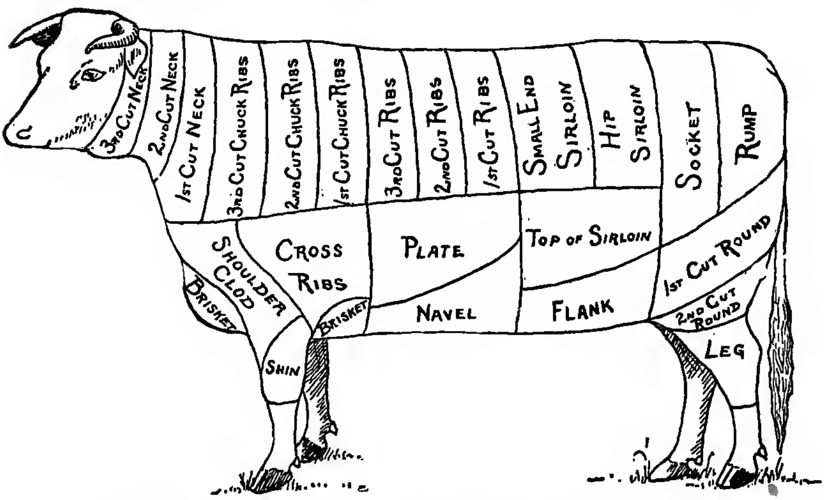


FIG. 1.—CUTS OF BEEF.—(*Nutrition Bulletins, Office of Experiment Stations.*)

strip of meat lying inside the loin, is found most fully developed in this cut. Porterhouse steak is a term most frequently applied to either the short steak or the tenderloin. It is not uncommon to find the flank cut so as to include more of the loin than is indicated in the figures, in which case the upper portion is called "flank steak." The larger part of the flank is, however, very frequently corned, as is also the case with the rump. In some markets the rump is cut so as to include a portion of the loin, which is then sold as "rump steak." The portion of the round on the outside of the leg is regarded as more tender than that on the inside, and is frequently preferred to the latter. As the leg lies upon the butcher's table this outside of the round is usually on the upper, or top, side, and is therefore called "top round." Occasionally the plate is called the "rattle."

In Fig. 2 is shown a side of beef with the various cuts indicated as used for commercial designation.

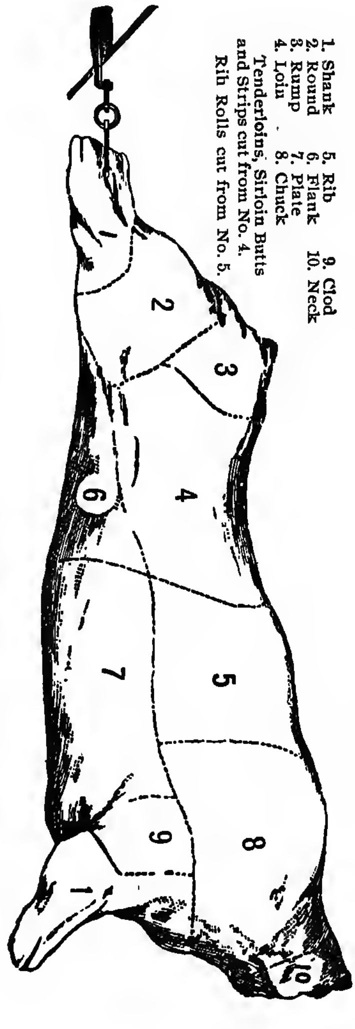


Fig. 2.—Commercial Cuts of Beef.—(*Courtesy of Armour & Co.*)

In Fig. 6 (page 20) is shown the interior view of a hog carcass with the cuts indicated as known to the trade.

The Cuts of Veal.—The method of cutting up a side of veal differs considerably from that employed with beef. This is illustrated by Fig. 3, which shows the relative position of the cuts in the animal and in a dressed side. The chuck is much smaller in proportion, and frequently no distinction is made between the chuck and the neck. The chuck is often cut so as to include a good deal of the portion here designated as shoulder, following more nearly the method adopted for subdividing beef. The shoulder of veal as here indicated includes, besides the portion corresponding to the shoulder in beef, the larger part of what is here classed as chuck in the adult animal. The under part of the fore quarter, corresponding to the plate in the beef, is often designated as breast in the veal. The part of the veal corresponding to the rump of beef is here included with the loin, but is often cut to form part of

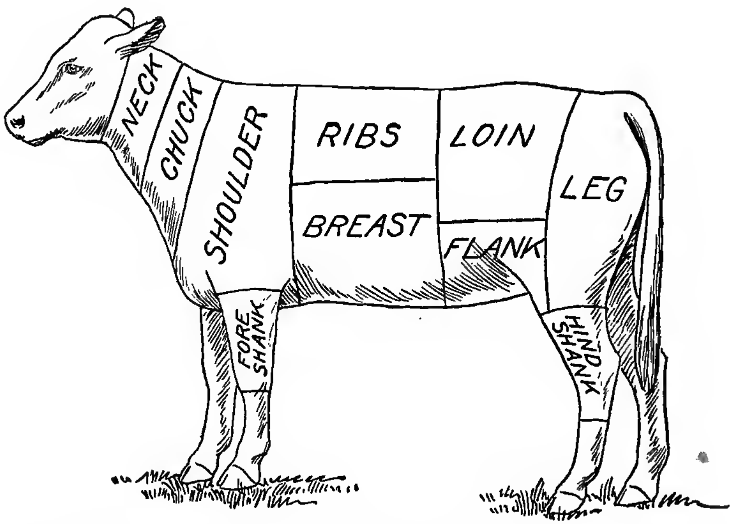


FIG. 3.—DIAGRAM OF CUTS OF VEAL.—(*Nutrition Bulletins, Office of Experiment Stations.*)

the leg. In many localities the fore and hind shanks of veal are called the "knuckles."

The Cuts of Lamb and Mutton.—Fig. 4 shows the relative position of the cuts in a dressed side of mutton or lamb and in a live animal. The cuts in a side of lamb and mutton number but six, three in each quarter. The chuck includes the ribs as far as the end of the shoulder blades, beyond which comes the loin. The flank is made to include all the under side of the animal. Some butchers, however, make a larger number of cuts in the fore quarter, including a portion of the cuts marked "loin" and "chuck" in Fig. 4, to make a cut designated as "rib," and a portion of the "flank" and "shoulder" to make a cut designated as "brisket." The term "chops" is ordinarily used to designate portions of either the loin, ribs, chuck, or shoulder, which are either cut or "chopped" by the butcher into pieces suitable for frying or broiling. The chuck and ribs are sometimes called the "rack."

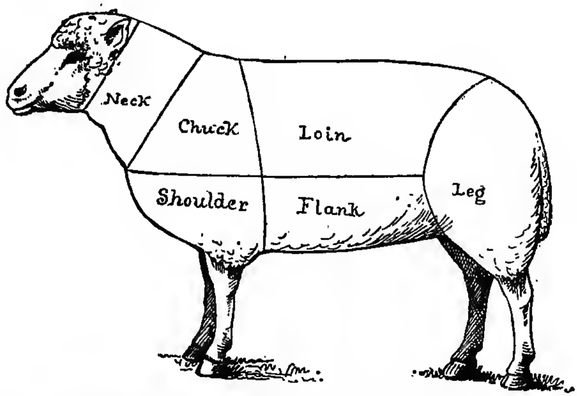


FIG. 4.—DIAGRAM OF CUTS OF LAMB AND MUTTON.—(*Nutrition Bulletins, Office of Experiment Stations.*)

The Cuts of Pork.—The method of cutting up a side of pork differs considerably from that employed with other meats. A large portion of the carcass of a dressed pig consists of almost clear fat. This furnishes the cuts which are used for "salt pork" and bacon. Fig. 5 illustrates a common method of

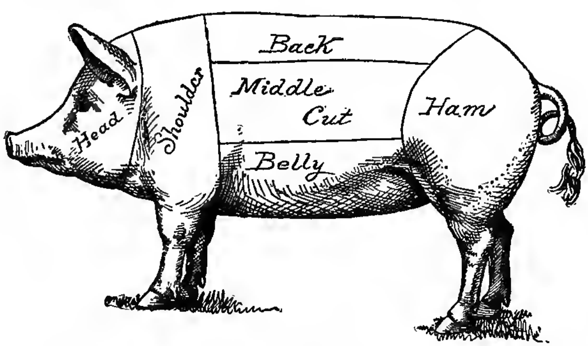


FIG. 5.—DIAGRAM OF CUTS OF PORK.—(*Nutrition Bulletins, Office of Experiment Stations.*)

cutting up pork, showing the relative position of the cuts in the animal and in the dressed side. The cut designated as "back cut" is almost clear fat and is used for salting and pickling. The "middle cut" is the portion quite generally used for bacon and for "lean ends" salt pork. The belly is salted or pickled, or may be made into sausages.

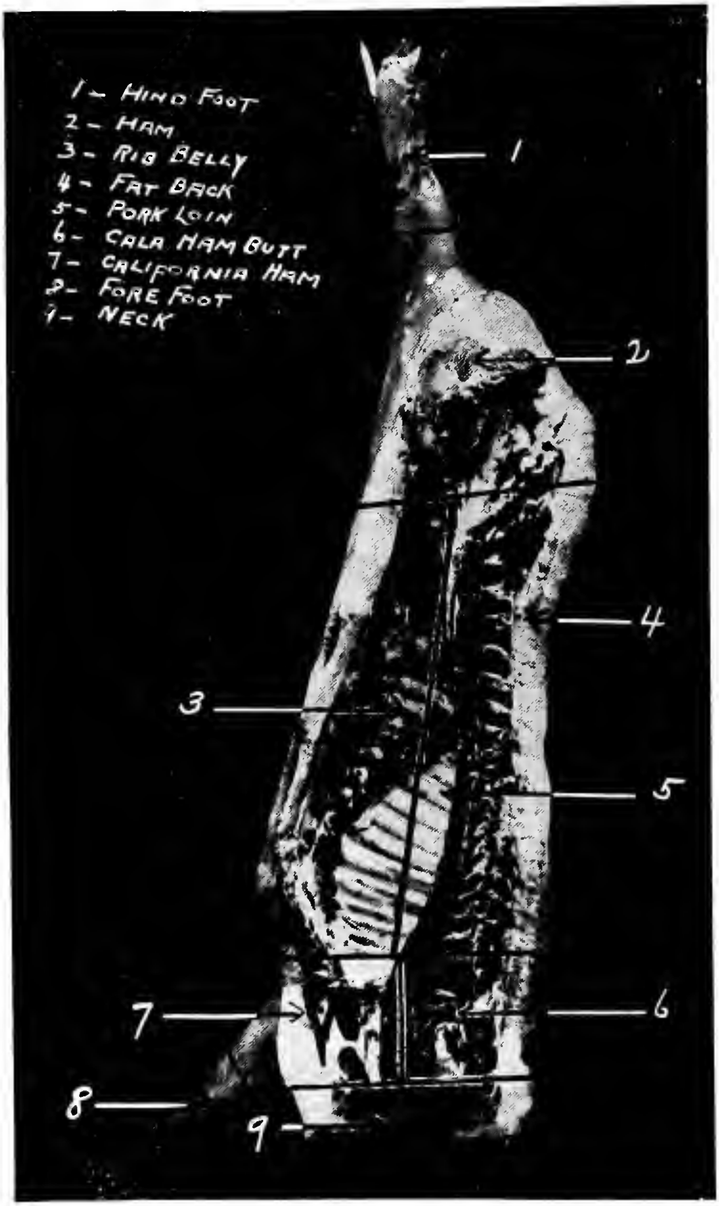


FIG. 6.—COMMERCIAL CUTS OF PORK.—(*Courtesy of Armour & Co.*)

Beneath the "back cut" are the ribs and loin, from which are obtained "spareribs," "chops," and roasting pieces, not designated in the figure. The hams and shoulders are more frequently cured, but are also sold fresh as pork "steak." The tenderloin proper is a comparatively lean and very small strip of meat lying under the bones of the loin and usually weighing a fraction of a pound. Some fat is usually trimmed off from the hams and shoulders which is called "ham and shoulder fat" and is often used for sausages, etc. What is called "leaf lard," at least in some localities, comes from the inside of the back. It is the kidney fat.

As stated above, cuts as shown in the diagrams herewith correspond to those of which analyses are reported in the table beyond, but do not attempt to show the different methods of cutting followed in markets in different parts of the United States.

Delivery of Fresh Meat to Consumers.—Perhaps the most important aid to the manufacturer, as well as a protection to the consumer, which modern science has offered to the public is the possibility of delivering fresh meats to consumers at a low temperature. A well equipped abattoir is provided with apparatus by means of which a constantly low temperature may be maintained in the room where the fresh meat is kept after the preparation described above. When the meats are to be distributed over long distances refrigerator cars or boats are provided where low temperature may be maintained.

Roast Beef.—The parts of the beef which are used for roasting are shown in the diagram, comprising a considerable portion of the hind quarter of the beef and part of the ribs. The roast is perhaps the most important of the parts of the beef for edible purposes. The average composition of the edible part of roast beef (before cooking) is given below:

Water,	60.14	percent
Solids,	39.86	"
Nitrogen,	4.47	"
Phosphoric acid,	.54	"
Sulfur,	.26	"
Fat,	10.48	"
Ash,	1.30	"
Protein,	27.95	"

Beefsteak.—The most important parts of the beef next to the roast are the parts used for steak. Beefsteaks have different names, such as tenderloin and sirloin, and when the latter two are joined together by the bone the whole is called porterhouse. There are also round steaks and rump steaks which are less highly prized portions of the meat, but in nutritive value are probably quite as valuable as the others mentioned. The average composition of the edible part of a large number of samples of beefsteak is given in the following table:*

* Means of numerous analyses in Bureau of Chemistry.

Water	63.95	percent
Solids	36.05	"
Nitrogen	4.54	"
Phosphoric acid	.59	"
Sulfur	.27	"
Fat	5.93	"
Ash	1.48	"
Protein	28.37	"

It is seen that the roast beef contains less water, less protein, and decidedly more fat than the steak.

Roast Lamb.—The parts of the lamb which are used for roasting are usually the hind quarters, although all of the parts are roasted at times. The average composition of a number of samples of lamb roast is given in the following table:*

Water	58.56	percent
Solids	41.44	"
Nitrogen	4.91	"
Phosphoric acid	.61	"
Sulfur	.28	"
Fat	9.12	"
Ash	1.30	"
Protein	30.71	"

Lamb chops or mutton chops are the short ribs with attached flesh of lamb or young sheep. They are considered to be the most desirable part of the young sheep or lamb for edible purposes. The average composition of the edible portion of a number of samples of lamb chops is given in the following table:

Water	63.98	percent
Solids	36.02	"
Nitrogen	4.35	"
Phosphoric acid	.61	"
Sulfur	.24	"
Fat	7.09	"
Ash	1.49	"
Protein	27.18	"

Roast lamb, as shown by the above data, has less water, more fat, and more protein than lamb chops.

Preservation of Fresh Meats.—After delivery the meats are at once consigned to refrigerator departments in the markets, where they are preserved until they pass into the consumer's hands. Thus, a properly fattened, properly slaughtered, and properly dressed piece of fresh meat may be brought into the consumer's hands in a manner at once unobjectionable and at the same time one which secures it admirably from contamination of any kind. So perfect are these means of transportation that fresh meat may be sent not only from city to city but across the sea, and reach the consumer as near perfection as human ingenuity can devise.

* From numerous analyses made in the Bureau of Chemistry.

Length of Storage.—The question of how long meat can be safely kept in cold storage of this kind is one which has not been decided. It may be said, however, that the period should not be extended any longer than is necessary and that the consumers of meat should be provided in ordinary times, if transportation is undisturbed, with practically fresh meat. It is evident that if the principal meat-packing centers are Chicago, Omaha, and Kansas City the cities and parts of the country remote from these localities must have meat somewhat older than those which are near by. If we pass to distant countries, as for instance, Europe, where fresh meats are received from the United States or even from Australia, the time elapsing between slaughter and consumption must necessarily be long. Thus the length of time in which meat should be left in cold storage after it is properly matured depends upon its geographic distribution and is not a matter to be decided arbitrarily.

When meats are not only kept in cold storage for transportation but are actually frozen, as is often the case, they can, of course, be kept for a much longer time than when subjected merely to a low temperature at or slightly above the freezing point. For this reason meats that are to be carried to a long distance and not to be consumed for a long time after preparation are usually frozen and kept so during transport.

Effect of Low Temperature on Enzymic Action.—Attention has been called to the fact that low temperature does not inhibit enzymic action, and, therefore, it must be admitted that this continued activity must gradually deteriorate the quality of the product. The question, therefore, which is the most important is not how long can meat be kept in a frozen condition but how short a time must it be kept. In all cases, therefore, of this kind the consumer is entitled to know the length of time during which his meat has been kept frozen, and this desirable condition of affairs is easily secured by the necessary local, state, and national inspection already mentioned.

Disposition of Fragments Arising From the Dressing of Beef.—It is evident that the fragments of sound, wholesome meat which is dressed for delivery to commerce are themselves edible and hence there can be no hygienic or other objection to preparations made from these fragments, such as sausage and other minced and comminuted meats which appear upon the market. In other words, the consumer is entitled to know that because a piece of meat is comminuted is no reason for supposing that it is not edible.

Sausage, mince meat, comminuted meat, potted, canned, and other meats or preparations from these sound, clean, edible fragments, necessarily rejected in the process of preparing fresh meats for curing and for consumption, are entitled to the same consideration and may be looked upon with the same certainty of purity by the consumer when properly inspected and prepared as the larger pieces.

The possibility of detecting any effects of disease in meats by inspection at the time of or after delivery is very remote and therefore the inspection before killing and during the process of manufacture should be a most rigid one in the case of these fragments. Such inspection and certification would restore public confidence in the purity and hygienic properties of these meats which not only are nutritious but by the spicing and condimental treatment which they receive are rendered highly palatable and desirable.

DETECTION OF DIFFERENT KINDS OF MEAT.

When meats are in large pieces they may be recognized by their anatomical characteristics. In order that this may be done, however, the piece of meat must either be ot a sufficient size to be recognized by its shape and general appearance or must have a bone of sufficient size to indicate its anatomical character.

According to the German law pieces of meat of less than eight pounds in weight are not supposed to be large enough to be recognized anatomically or otherwise with certainty. This, however, is a matter which pertains more to the meat of animals from which the bone is taken rather than to its actual size. It requires some little expert knowledge of the anatomy of animals in order to distinguish these pieces, but one who is in the habit of purchasing or cutting meats acquires this knowledge without any special study.

Odor and Taste.—Each kind of meat may also be detected both by its odor and taste, as well as by its physical appearance and shape. Beef, mutton, pork, and other meats in a proper state of preparation and preservation have characteristic odors and flavors by which they are easily detected. One of the common faults of cooking is the putting together of meats of various kinds in the same oven, by means of which the odors become so intermingled that in small pieces even the experienced taster may not always be able to discriminate between them.

Detection of Meat by Microscopic Appearance.—Meats are so nearly related histologically that the microscope is not a certain means of detecting the different varieties. Were this the case it would be easy to identify the different kinds of meat which may be found in a finely comminuted mixture. The expert microscopist may have difficulty in discriminating between different microscopic portions of meat, but the microscope is of practically no advantage to any but an expert and not a very great advantage to him. The fibers of some animals vary in size, coarseness or fineness of texture, and other characteristics as much as fibers do from different animals.

Detection by Chemical Examination.—The most satisfactory method of detecting meats is by means of their chemical examination. There are two distinct points which are kept in view in a chemical examination. One is the presence of glycogen, which in quantities of more than one percent is characteristic of horse meat. Unfortunately, this test can only be applied to a meat in practically a fresh state, as the glycogen is rapidly changed into other forms of carbohydrate substances, which makes it difficult to identify. The chemical examination, therefore, which is of the most value is that which is performed upon the fat. The fat of different animals has different physical and chemical characteristics. The fats crystallize in different forms and have different melting points,—also the fatty acids derived therefrom. They absorb different quantities of iodin and bromin, and have other physical and chemical properties which are peculiar to each variety.

A careful examination of the fat, therefore, will lead to an approximate degree of knowledge concerning the character of the flesh from which it has been derived. For instance, lard and beef fat are easily distinguished from each other. In case a minced meat is made wholly of one kind of flesh or of one kind of animal the chemical examination of the fat will, with a considerable degree of certainty, lead to its identification. In the same manner, if a minced meat be made up of equal parts of two different kinds of animals the characteristics of the fats will lead to the identification of the two sources of meat. If, however, one kind of meat be mixed in only a small proportion, say 10 or 15 percent, of another, the chemical methods of separation are not to be relied upon. None of these chemical or physical methods, unfortunately, is of value in the hands of any but an expert, and, therefore, cannot be regarded as a common means of identification. For this reason the only common manner of identification of the kinds of meats which are sent out to the consumer at large must consist in the general knowledge of their anatomical, physical, palatable, and gustatory properties outlined above.

In all cases the consumer must eventually rely upon the official inspection and the label which accompanies the meat or which should accompany it.

Dried Meat.—A very effective method of preserving meat is practiced in certain of the arid regions of the country by exposing it to the dry air and sunlight. Meats prepared in this way are often called "jerked" meats. The small amount of aqueous vapor in the air is not sufficient to maintain the life of the ordinary fermentative germs, and they are, therefore, destroyed by desiccation. Meat which is exposed under such circumstances does not become infected with any fermentative germ, and the moisture which it contains is rapidly given off in the dry air surrounding it. For this purpose the meat is cut into thin strips and suspended by appropriate means in the air and exposed to the direct sunlight. In a short time the moisture disappears, and the hard dry pieces keep indefinitely in certain arid regions of this country. The meat also maintains a fair degree of palatability and practically all of its nutrient properties, so that when properly cooked it is a palatable and nutritious dish. Probably of all the methods of preserving meat this one is the least open to objection, since not even spices or condimental substances are necessary in order to preserve the meat from decay. By reason of the change in its physical appearance, however, which makes it less attractive, this method is not likely to come into general use in the ordinary preservation of meat.

Dried beef is also prepared by preserving the meat by condimental substances and, instead of placing it in brine, drying it artificially. Chipped or dried beef is a common article of commerce and is prepared in the manner described above. This meat, however, has already been treated with condimental substances, and hence the drying is only one of the means of preservation. Dried or chipped meats are often smoked also as well as desiccated, so that in their preparation more than one method of preservation is employed.

Pickled Meats.—The method of preserving meats in a liquid environment is sometimes called pickling. All kinds of meat are pickled in this way, but pork especially. The pickling brine may be simply made of common salt, though other substances, such as sugar, vinegar, and spices, are used. The brine also sometimes contains a chemical preservative which is highly objectionable on the general ground of the harmfulness of these substances. The preservative commonly used is either sulfite of soda or boric acid. The making of a pickled meat of this kind should be discouraged. The vinegar which is employed or acetic acid may be injected into the carcass before it is cut up. When the arteries or veins are filled with vinegar in this way it rapidly permeates to all parts of the meat and acts as an excellent and unobjectionable preservative in all cases where an acid taste is desired. It is claimed that carcasses which have been injected with vinegar in this way are easily preserved, and require far less salt and other condimental substances than when not so treated. As vinegar is a condimental substance used everywhere, and one which promotes digestion when used in proper quantities, the preservation of meats or the pickling of meats by a previous injection of vinegar is not objectionable.

COMPOSITION OF THE FLESH OF PIGS.

Extensive investigation of the composition of the flesh of pigs has been made in the Bureau of Chemistry (Bulletin 53). The pigs upon which these examinations were made were specially bred and fattened at the Agricultural Experiment Station of Iowa, and were prepared for the market by the most approved modern style of feeding. They were slaughtered according to the approved method and immediately, after proper preparation, the carcasses were placed in cold storage, where they were kept until removal for the purpose of dissection and preparation of the samples for analyses. Expert butchers from Washington were secured for the dissecting and dressing of the pigs in the manner in which it would be done for the best market. The pigs were of different varieties, namely, Berkshire, No. 1; Tamworth, No. 2; Chester White, No. 3; Poland China, No. 4; Duroc Jersey, No. 5, No. 6, No. 7; Yorkshire, No. 8.

TABLE A.—WEIGHTS OF WHOLE CUTS AND DATA RELATING TO THE PREPARATION OF AIR-DRY SAMPLES.

PIG No. 1.—BERKSHIRE.

Names of Cuts.	Weights of Whole Cuts.						Direct Determinations on Original Material.		Preparation of Air-dry Samples.							
	Chicago.			Washington.			Water.	Fat.	Weight of fresh sample.	Air-dry sample of original material	Weight of air-dry sample after extraction.	Weight of fat.	Air-dry sample plus fat.	Weight of water removed	Removed in preparation of sample. Water.	Removed in preparation of sample. Fat.
	Lbs.	*Oz.*	*Grams.*	*Lbs.*	*Oz.*	*Grams.*	*Per ct.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Per ct.*	*Per ct.*
Two American clear backs,	35½	0	16,102.8	34	6	15,592.5	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	31.33	58.21	833.0	13.16	109.6	458.0	567.6	265.4	31.86	54.98
Two clear bellies,	19½	0	8,845.2	19	4	8,731.8	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	36.09	52.69	741.2	14.33	106.2	362.1	468.3	272.9	36.82	48.84
Two short-cut hams,	23½	0	10,659.6	23	5	10,574.6	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	60.29	22.19	532.5	22.95	122.2	88.3	210.5	322.0	60.47	16.58
Two New York shoulders,	20½	0	9,298.8	20	10	9,395.5	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	54.97	29.01	532.5	17.65	94.0	152.9	246.9	285.6	53.64	28.71
Four feet (seven hoofs),	3½	0*	1,594.2†	..		1,514.1	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	59.78	17.04	221.1	25.10	55.5	33.7	89.2	131.9	59.66	15.24
Spareribs,	5	0	2,268.0	..		2,212.0	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	50.33	30.05	359.9	20.81	74.9	98.6	173.5	186.4	51.78	27.39
Tenderloins.	1	0	453.6	..		470.8	67.14	9.14	427.9	27.11	116.0	26.6	142.6	285.3	66.67	6.21
Neck bones,	2	0	907.2	..		842.5	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	53.82	28.72	390.6	20.02	78.2	100.5	178.7	211.9	54.25	25.73
Backbones,	3½	0	1,587.6	..		1,580.0	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	51.89	27.16	397.5	22.24	88.4	102.1	190.5	207.0	52.08	25.69
Trimmings,	18	0	8,164.8	16	9	7,512.8	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	29.68	62.00	783.7	9.72	76.3	479.2	555.5	228.2	29.11	61.17
Tail,	¼	0	113.4	..		363.0	..	..	..	..	..	..	..	..	..	..
Meat,	..		..	..		..	23.99	69.25	199.2	8.73	17.4	134.7	152.1	47.1	23.64	67.62
Total,	132¼	0	59,995.2	..		58,789.6	..	..	..	..	..	..	..	..	..	..

* Missing hoof, 6.6 grams.

† Corrected for missing hoof.

Preparation of Samples for Analyses.—The meat obtained from all of the cuts of the same kind in each sample was passed through a meat chopper two or three times in order to get an even, finely divided condition. A portion of known weight was then placed in a dish and dried in a steam oven at a temperature of boiling water or slightly above and heated until the fat had well separated so that it could be poured off into a flask, with care not to remove any of the water which may have separated with it. Small samples were removed before drying for the determination of the exact quantity of fat and water therein, and the results of these analyses were used for calculating the relative portion of the large samples. Samples of skin, bones, marrow, spinal cord, tendons, hoofs, and other parts of the animal were also carefully secured and subjected to analyses. In this way the whole animal was subjected to examination for analytical data, and at the same time each particular part of it, in so far as its relation to the market is concerned, was kept separated. In Table A are found the weight of the whole cut and the data relative to the preparation of the air-dried sample.

The data show that there was a slight loss of water during the transit from Chicago to Washington. The part of the pig which has the largest

TABLE B.—WEIGHTS OF PARTS FROM EACH CUT AND DATA RELATING TO THE PREPARATION OF AIR-DRY SAMPLES.

PIG No. 1.—BERKSHIRE.

Names of Parts and Cuts.	Weights of Parts. From each cut.	Total.	Of entire pig.
Meat (fat and lean):	*Grams.*	*Grams.*	*Percent.*
Backs,	14,767.9	..	..
Bellies,	8,230.6	..	..
Hams,	9,407.9	..	..
Shoulders,	8,448.2	..	..
Feet,	325.3	..	..
Spareribs,	1,683.8	..	..
Tenderloins,	470.8	..	..
Neck bones,	493.2	..	..
Backbones,	704.0	..	..
Trimmings,	7,021.5	..	..
Tail,	291.7	..	..
		51,844.9	88.19
Bones:			
Backs,	191.1	..	..
Bellies,	81.4	..	..
Hams,	879.6	..	..
Shoulders,	693.8	..	..
Feet,	802.6	..	..
Spareribs,	528.2	..	..
Neck bones,	336.1	..	..
Backbones,	833.5	..	..
Trimmings,	71.0	..	..
Tail,	27.1	..	..
Total,	..	4,444.4	..
Marrow,	69.7	69.7	0.12
Total bones less marrow,	..	4,374.7	7.44

TABLE C.—ANALYTICAL DATA FOR MEATS.

PIG No. 1.—BERKSHIRE.

Names of Cuts.	Air-dry sample: Percent of original material.	Percent Air-dry Material.								Percent Original Material.																Total.*
				Nitrogen.						Water.			Fat.				Nitrogen.				Nitrogenous substances.					
		Water.	Fat.	Total.	Of proteids insoluble in hot water.	Precipitated by bromin.	Of flesh bases.	Lecithin.	Ash.	In preparing sample.	In steam-dry material.	Total.	In preparing sample.	In steam-dry material.	Total.	Lecithin.	Total.	Of proteids insoluble in hot water.	Precipitated by bromin.	Of flesh bases.	Proteids insoluble in hot water.	Gelatinoids.	Flesh bases.	Total.	Ash.	
Two American backs, ...	13.16	3.14	20.55	11.32	8.51	0.62	2.19	1.16	3.89	31.86	0.41	32.27	54.98	2.71	57.69	0.15	1.49	1.12	0.08	0.29	7.00	0.50	0.91	8.41	0.51	98.46 98.88
Two clear bellies, ...	14.33	3.14	21.59	11.15	7.78	0.65	2.72	0.99	3.85	36.82	0.45	37.27	48.84	3.09	51.93	0.14	1.60	1.12	0.00	0.39	7.00	0.56	1.22	8.78	0.55	98.11 98.53
Two short-cut hams, ...	22.95	4.14	15.43	11.85	9.77	0.48	1.60	1.10	4.18	60.47	0.95	61.42	16.58	3.54	20.12	0.25	2.72	2.24	0.11	0.37	14.00	0.69	1.15	15.84	0.96	99.28 98.34
(Fat extracted with ether), .	16.58	..	..	0.22	..	..	..	2.43	..	..	..	..	..	..	..	0.40	0.04	..	..	..	..	..	..	..	..	
																0.65										
Two New York shoulders, .	17.65	2.31	2.10	13.76	10.22	0.73	2.81	0.85	5.03	53.64	0.41	54.04	28.71	0.37	29.08	0.15	2.43	1.80	0.13	0.50	11.25	0.81	1.56	13 62	0.89	98.49 97.63
Four feet, ...	25.10	6.46	6.32	13.73	7.75	3.00	2.98	0.75	3.28	59.66	1.62	61.28	15.24	1.59	16.83	0.20	3.45	1.95	0.75	0.75	12.19	4.69	2.34	19.22	0.82	96.86 98.15
(Fat extracted with ether), .	15.20	..	..	0.13	..	..	..	2.68	..	..	..	..	..	..	..	0.41	0.02	..	..	..	..	..	..	..	..	
																0.61										
Spareribs, ...	20.81	3.66	8.23	13.03	10.31	0.89	1.83	1.68	4.80	51.78	0.76	52.54	27.39	1.71	29.10	0.35	2.71	2.15	0.18	0.38	13.44	1.13	1.19	15.76	1.00	97.14 98.40
Tenderloins, ...	27.11	5.14	9.47	12.50	10.95	0.28	1.27	1.82	4.30	66.67	1.39	68.06	6.21	2.57	8.78	0.49	3.39	2.97	0.08	0.34	18.56	0.50	1.06	20.12	1.17	97.57 98.13
Neck bones, ...	20.02	7.23	10.93	12.25	9.97	0.59	1.69	1.33	4.02	54.25	1.45	55.70	25.73	2.19	27.92	0.27	2.45	1.99	0.12	0.34	12.44	0.75	1.06	14.25	0.81	97.60 98.68
(Fat extracted with ether), .	18.69	..	..	0.21	..	..	..	2.17	..	..	..	..	..	..	..	0.41	0.04	..	..	..	..	..	..	..	..	
																0.68										
Backbones, ...	22.24	3.36	6.88	13.03	10.36	0.62	2.05	1.20	5.59	52.08	0.75	52.83	25.69	1.53	27.22	0.26	2.90	2.30	0.14	0.46	14.38	0.87	1.44	16.69	1.24	96.98 97.98
Trimmings, ...	9.72	3.69	8.34	13.09	8.54	1.11	3.44	1.16	4.23	29.11	0.36	29.47	61.17	0.81	61.98	0.11	1.27	0.83	0.11	0.33	5.19	0.69	1.03	6.91	0.41	99.00 98.77
Tail, ...	8.73	4.30	6.97	13.45	10.56	0.98	1.91	1.98	4.41	23.64	0.38	24.02	67.62	0.61	68.23	0.17	1.17	0.92	0.09	0.16	5.75	0.56	0.50	6.81	0.39	100.44 99.45

* In this column the totals obtained by both the direct and the indirect determination of water and fat are given. The upper number in each case was obtained by use of the results of direct determinations of these constituents; for the lower number in each case the results obtained during the preparation of the sample, and in the analysis of the dry-air sample, were used. Lecithin is not included in the totals given in this table.

ABLE D.—ANALYTICAL DATA FOR BONES, MARROW, SKIN, SPINAL CORD, TENDONS, AND HOOFS.

PIG No. 1.—BERKSHIRE.

Names of Parts.	Air-dry sample, percent of original material.	Percent Air-dry Material.								Percent Original Material.																
		Water.	Fat.	Nitrogen.				Lecithin.	Ash.	Water.			Fat.			Lecithin.	Nitrogen.				Nitrogenous substances.				Ash.	Total.
				Total.	Of proteids insoluble in hot water.	Precipitated by bromin.	Of flesh bases.			In preparing sample.	In residual material.	Total.	In preparing sample.	In residual material.	Total.		Total.	Of proteids insoluble in hot water.	Precipitated by bromin.	Of flesh bases.	Proteids insoluble in hot water.	Gelatinoids.	Flesh bases.	Total.		
Bones,	52.67	5.72	0.52	6.18	5.32	0.11	0.75	0.84	49.59	35.93	3.01	38.94	11.40	0.27	11.67	0.44	3.26	2.80	0.06	0.40	17.50	0.38	1.25	19.13	26.12	95.86
(Fat extracted with ether),	11.40	(.61)	..	0.29	..	..	..	..	(.28)	..	(.07)	..	..	..	..	..	0.03	..	..	..	..	..	..	..	(.03)	..
Marrow,	4.44	6.68	0.19	8.31	7.08	0.65	0.48	..	..	14.06	0.30	14.36	81.50	0.01	81.51	..	0.37	0.32	0.03	0.02	2.00	0.19	0.06	2.25	..	98.12
(Fat extracted with ether),	17.36	..	..	0.07	..	..	..	2.64	..	..	..	..	..	..	..	0.46	0.01	..	..	..	..	..	..	..	..	..
Skin,	36.93	8.31	3.28	15.02	10.95	2.89	1.18	0.33	1.70	47.17	3.07	50.24	15.90	1.21	17.11	0.12	5.55	4.04	1.07	0.44	25.25	6.69	1.37	33.31	0.63	{ 108.44 101.89
(Fat extracted with ether)	15.90	..	..	0.15	..	..	..	1.85	..	..	..	..	..	..	..	0.29	0.024	..	..	..	..	..	..	..	..	..
Spinal cord,	8.80	6.01	8.28	8.85	7.02	1.26	0.57	..	..	65.17	0.53	65.70	26.03	0.73	26.76	0.41 ..	0.78	0.62	0.11	0.05	3.88	0.69	0.16	4.73	..	97.19
Tendons,	31.93	10.23	1.53	14.10	11.26	2.22	0.62	0.39	3.71	55.16	3.27	58.43	12.91	0.49	13.40	0.13	4.50	3.59	0.71	0.20	22.44	4.44	0.62	27.50	1.18	100.51
(Fat extracted with ether),	4.81	..	..	0.23	..	..	..	6.65	..	..	..	..	..	..	..	0.32	0.01	..	..	..	..	..	..	..	..	..
Hoofs,	63.44	7.14	1.35	14.63	..	..	..	..	1.46	36.56	4.53	41.09	..	..	0.86	0.45 ..	9.28	..	..	..	..	..	..	58.00	0.93	100.88

percentage of fat is the meat of the tail, while the smallest percentage is found in the tenderloins. The largest percentage of water in any part of the meat is in the tenderloins and the smallest in the meat of the tail.

Similar data were obtained for all of the other samples used, but the chemical composition is so nearly the same that it is not advisable to repeat the data for the other varieties. The Berkshire for which the data are given may be taken as a fair representative of the composition of the varied parts of the meat of pigs. The comparative weights of various parts of the Berkshire pig are given in Table B.

The data show that 88.19 percent of the weight of the carcass, after dressing, is composed of meat, fat, and lean, and 7.56 percent of bone. The complete data for the variety of Berkshire pig may be taken as a type for the other varieties and is given in Table C.

The composition of the bone, marrow, skin, spinal cord, tendons, and hoofs of the Berkshire pig is shown in Table D.

The percentages of the various parts of the original material of the Berkshire pig are found in Table E.

TABLE E.—REVISED ANALYTICAL DATA.

PIG No. 1.—BERKSHIRE.

[Percents original material.]

Names of Cuts and Parts.	Water.	Fat.	Nitrogenous Substances.				Lecithin.*	Ash.	Total.
			Proteids, insoluble in hot water.	Gelatinoids.	Flesh bases.	Total.			
Meat:									
American backs,	32.27	57.69	7.00	0.50	0.91	8.41	0.15	0.51	99.03
American bellies,	37.27	51.93	7.00	0.56	1.22	8.78	0.14	0.55	98.67
Short-cut hams,	60.29†	22.19	14.00	0.69	1.15	15.84	0.65	0.96	99.93
New York shoulders,	54.97†	29.01	11.25	0.81	1.56	13.62	0.15	0.89	98.64
Four feet,	61.28	16.83	12.19	4.69	2.34	19.22	0.61	0.82	98.76
Spareribs,	52.54	29.10	13.44	1.13	1.19	15.76	0.35	1.00	98.75
Tenderloins,	68.06	8.78	18.56	0.50	1.06	20.12	0.49	1.17	98.62
Neck bones,	55.70	27.92	12.44	0.75	1.06	14.25	0.68	0.81	99.36
Backbones,	52.83	27.22	14.38	0.87	1.44	16.69	0.26	1.24	98.24
Trimmings,	29.68†	62.00	5.19	0.69	1.03	6.91	0.11	0.41	99.11
Tail,	24.02	68.23	5.75	0.56	0.50	6.81	0.17	0.39	99.62
Bones,	38.94	11.67	17.50	0.38	1.25	19.13	0.44	26.12	96.30
Marrow,	14.36	81.51	2.00	0.19	0.06	2.25	0.46‡	..	98.58
Skin,	50.24	17.11	25.25	6.69	1.37	33.31	0.41	0.63	101.70
Spinal cord,	65.70	26.76	3.88	0.69	0.16	4.73	1.47§	0.40‖	97.19
Tendons,	58.43	13.40	22.44	4.44	0.62	27.50	0.45	1.18	100.96
Hoofs,	41.09	0.86	..	..	..	58.00	..	0.93	100.88

* Lecithin in extracted sample only, unless otherwise noted.

† Result of direct determination on original material. Other numbers in this column represent the sum of the percent of water removed in the preparation of sample and the percent of water remaining in the air-dry sample.

‡ In fat extract.

§ In fat extract, calculated from averages for like cuts.

‖ Calculated from averages of like cuts.

TABLE F.—DATA FOR THE ENTIRE DRESSED ANIMAL; THE HEAD, LEAF LARD, AND KIDNEYS HAVING BEEN REMOVED.

PIG NO. 1.—BERKSHIRE.

Names of Parts.	Weight of Parts—		Of Entire Pig.	Weight of Each Constituent.							
						Nitrogenous substances.					
	From each cut.	Total.		Water.	Fat.	Proteids, insoluble in hot water.	Gelatinoids.	Flesh bases.	Total.	Lecithin.	Ash.
Meat (fat and lean):	*Grams.*	*Grams.*	*Percent.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Backs,	14,767.9	..	..	4,765.6	8,519.6	1,033.8	73.8	134.4	1,242.0	22.15	75.3
Bellies,	8,230.6	..	..	3,067.5	4,274.2	576.1	46.1	100.4	722.6	11.52	45.3
Hams,	9,407.9	..	..	5,672.0	2,087.6	1,317.2	64.9	108.2	1,490.3	61.15	90.3
Shoulders,	8,448.2	..	..	4,644.2	2,450.6	950.4	68.4	131.8	1,150.6	12.67	75.2
Feet,	325.3	..	..	199.3	54.7	39.6	15.3	7.6	62.5	1.98	2.7
Spareribs,	1 683.8	..	..	884.7	490.0	226.4	19.0	20.0	265.4	5.89	16.8
Tenderloins,	470.8	..	..	320.4	41.3	87.4	2.3	5.0	94.7	2.31	5.5
Neck bones,	493.2	..	..	274.7	137.7	61.4	3.7	5.2	70.3	3.35	4.0
Backbones,	704.0	..	..	371.9	191.7	101.3	6.1	10.1	117.5	1.83	8.7
Trimmings,	7,021.5	..	..	2,084.0	4,353.1	364.4	48.4	72.3	485.1	7.72	28.8
Tail,	291.7	..	..	70.1	199.1	16.8	1.6	1.5	19.9	0.50	1.1
Total for meats,	..	51,844.9	88.19	22,354.4	22,799.6	4,774.8	349.6	596.5	5,720.9	131.07	353.7
Bones (less marrow),	..	4,374.7	7.44	1,703.6	510.6	765.6	16.6	54.7	836.9	19.25	1 142.6
Marrow,	..	69.7	0.12	10.0	56.8	1.4	0.2	0.1	1.7	0.32*	..
Skin,	..	2,232.5	3.80	1,121.6	381.9	563.7	149.4	30.6	743.7	9.15	14.1
Spinal cord,	..	55.7	0.09	36.6	14.9	2.2	0.4	0.1	2.7	0.82†	0.2‡
Tendons,	..	159.5	0.27	93.2	21.4	35.8	7.1	1.0	43.9	0.72	1.9
Hoofs,	..	52.6	0.09	21.6	0.4	..	..	..	30.5	..	0.5
Total weights,	..	58,789.6	...	25,341.0	23,785.6	6,143.5	523.3	683.0	7,654.9	161.33	151.3
Total percents of original material,	..	..	..	43.10	40.46	10.45	0.89	1.16	13.02	0.27	2.57

* In fat extract. † In residue and fat extract, calculated from averages of like cuts. ‡ Calculated from average of like cuts.

The data for the entire dressed animal after the removal of the head, hoofs, lard, and kidneys are shown in Table F.

General Conclusions.—The composition of the flesh of pigs has been given in detail for two reasons. First, because the data relative to this point are much more complete than those of any other flesh product and were obtained in a more systematic way. In the second place, pork is one of the chief meat products of the United States,—the industry being one of great magnitude, and pork being a common article of diet among all classes of people. Further than this, the data indicate the general character of fresh meat, and illustrate as well as that of any of the typical animals the nutritive value and properties of flesh. The study of pork, therefore, may be regarded as a typical study of meat products. It is quite as important that all people should be informed respecting the nature of the wholesome meat which they consume and its value as a diet as it is that they should be certain these meats are procured from healthy animals and in a sanitary way. These two classes of knowledge together give a complete scheme of information which the consumers in this and other countries are entitled to have.

Pork, by many hygienists, is regarded as the least desirable of meat products, and it is not the purpose here to combat that idea. Granting, however, for the sake of argument, that pork is a less desirable meat food than those derived from cattle or sheep, that is all the more reason for knowing particularly everything connected with it. Modern investigations have appeared to establish the fact that swine are less subject to those forms of disease, with the exception of trichinosis, which tend to infect the meat and make it unfit for consumption than cattle or sheep. The diseases to which swine are usually subject act quickly, as a rule, and are speedily fatal, as in the case of hog cholera, whereas the diseases most to be feared in cattle and sheep are those of slow activity and those of a nature which is often not revealed until slaughter, namely, tubercular diseases. In so far, therefore, as infection from disease is concerned, previous to slaughter, it appears that the flesh of swine is less objectionable and less open to suspicion than that of cattle or sheep. One of the chief objections to the use of pork in any form, whether fresh or cured, has been based upon the unsanitary habits of the animals themselves. With the modern methods of cleanliness and care, however, the conditions under which the pigs grow and fatten are, or should be, quite as sanitary as those surrounding cattle and sheep. The consumer, of course, has the right to insist upon such sanitary conditions and these, under present laws or those which are to be enacted, will doubtless be supplied. It is believed that in this country sanitary environments and a sanitary method of feeding will develop types of animals superior to those grown in other countries, where the population is denser and where the facilities for the proper growth and fattening of the animal are less abundant. It is hoped that the general diffusion of knowledge respecting all food products among our people will aid greatly in securing these very desirable results.

PRESERVED MEATS.

Meats which cannot be eaten at the time of or soon after slaughter are necessarily preserved until the time of consumption. It is difficult to draw a definite line between a preserved and a fresh meat. A general distinction is the following: Fresh meat is meat which is prepared for consumption without the use of any condiment or preservative, without sterilization, and with none of the artificial methods of keeping, except cleanliness and a low temperature.

The above definition, as will be seen, covers meat placed in cold storage. A special distinction, however, must be made in this case between meat placed in cold storage for the purpose of transportation only and meat placed in cold storage to be kept for an indefinite time. Where meats are prepared for consumption by slaughter and appropriate dressing and shipped long distances to the consumer the cold storage car, ship, and warehouse become a necessity. There is some reasonable limit for keeping such products, beyond which they should be differentiated from fresh meats. Whenever meats are kept in cold storage so long as to afford the opportunity for the growth of a mould, or undergo other changes of a chemical or physical character which distinguish them from the fresh products, they should be placed in a different class. Fresh meats may, therefore, be divided as follows:

Class I. Meats intended for immediate consumption and passed to the consumer within, at the most, one week after slaughter. Class II. Cold storage meats, which are placed in refrigerators, frozen, and kept for a longer period than one week. There is evidently also a limit to the length of time which meat should remain in cold storage, no matter how low the temperature may be, since the action of organisms which produce decay cannot be entirely overcome. The exact limit at which frozen meats can be kept without becoming inedible has not been determined. Without this determination, however, it is advisable that such limit should not be approached. Inasmuch as the supply of fresh meat is practically uniform, or can be made so by the dealer therein, there seems no good reason for the storage of meat in refrigerator compartments for a longer time than is necessary for transportation and a reasonable time thereafter for passing into consumption, except in cases of emergency. It might be safe to say that no meat should be kept in a cold storage warehouse longer than a month after its reception. Numerous instances might be cited in which meat may be kept for a much longer time, but the question for the consumer is not how long a while meats can be kept but how soon they can be placed in his hands. In this connection it should not be forgotten that it is the opinion of perhaps the majority of hygienists and connoisseurs that fresh meat, especially beef, improves for a certain length of time in cold storage. It is probable that the fresh beef which is served to the people of the United States is on an average a month old, and is said to be improved by keeping this length of time. This is a question, however, which is still undetermined, and it deserves a further investigation. Under present conditions it is well to know the truth respecting these matters and to realize that the fresh meat we get, such as beef and mutton, is not direct from the shambles but has been kept for at least four weeks in cold storage.

Effect of Long Cold Storage.—It has been stated in semi-scientific publications that the flesh of a mammoth incrusted in polar ice and presumably thousands of years old has been found to be intact and edible. This story, lacking corroboration, is hardly in harmony with known facts. The author had the opportunity of examining a quarter of beef which had been kept frozen in a warehouse for more than eleven years. This meat was found to be wholly inedible. It had an unpleasant and mummy-like odor, was light in fiber and color, having evidently lost a large part of its weight, and was of a character wholly unsuitable for consumption. This fact appears to show that eleven years is too long a time in which to keep meat frozen. In fact, it is scarcely worth while, from a practical point of view, to discuss so long a limit. Only the necessary time for the preparation and transportation of the meat is to be considered, and the sanitary laws of the nation, states, and municipalities should undoubtedly regulate the time of cold storage and see that all packages of meat exposed for sale are plainly tagged as to the date of slaughter, in order that the consumer may know.

In the consideration of the subject of preserved meats there are excluded all meats delivered in the fresh state for consumption and meats kept in cold storage in a fresh state during the necessary time of preparation and transportation say, on the whole, from four to eight weeks. Meats kept longer than this may generally be considered as preserved meats, even when cold is the only factor active in their preservation.

Method of Preserving Meats.—Aside from cold storage there are four methods in vogue for preserving meats. These may be classified as follows: (1) Curing with the aid of condimental substances; (2) treatment with chemical and non-condimental preservatives; (3) sterilization with heat; (4) drying. All of these, except the second, may be regarded as legitimate means of preserving meats.

Curing with Condimental Substances.—This method of preserving meat has been practiced from the remotest antiquity. The chief condimental substances employed are salt, sugar, vinegar, and wood smoke. With the proper technical skill and knowledge of the process, meats can be preserved in this way, and at the same time aromas and flavors developed which are considered most agreeable by the consumer and which give an additional value to the product. It is not to be claimed in any case that condimental preservatives add anything to the nutritive value of the product, except in so far as condiments themselves aid the digestion by exciting in a perfectly proper way the activity of the glands which secrete the digestive ferments.

It is not the purpose here to describe the technical processes used. In general it may be said that the application of salt is the first process, and this is done as soon after the slaughter as it is possible to secure the proper cooling of the carcass, usually from twenty-four to forty-eight hours. The meat, properly cut into the forms known to commerce, is carefully packed and heavily salted, and allowed to remain for some time in contact with the salt or with the brine which is produced therefrom. The salt penetrates to the interior of the flesh and hardens, to some extent, the tissues, abstracting water therefrom, and, without being wholly germicidal in character, prevents the introduction of eggs of insects and the development of ordinary germ life. The salt, however, does not entirely inhibit the enzymic action which tends to ripen the meat and make it more palatable. It naturally gives to the meat the salty flavor which is demanded by the taste in a preparation of this kind.

Sugar is used, if at all, always in connection with salt as a preservative for meats. It may be employed in the pure state, but is usually the yellow or low-grade sugar or molasses. It gives to the preserved meat, especially ham, a flavor and quality much appreciated by the consumer.

The application of wood smoke is usually the last process after the meats are properly cured in salt and sugar. The pieces are suspended in a convenient room and underneath is built a fire of hard wood, which is kept smouldering as much as possible in order to produce the maximum of smoke and minimum of heat. Oak, maple, and hickory woods are most highly prized for this purpose, since they develop on burning a rich aroma which imparts to the flesh a delicate flavor.

The object of curing the meat is, first, to prevent decay; second, to impart the flavor of the well known condiments mentioned above, and third, to favor the development of the enzymic action which has the effect not only of making the meat more aromatic than it otherwise would be, but also more pleasant to the taste.

The curing of meat in this respect may be compared to the development of a cheese, except that the enzymic action in the case of meat is one of minimum extent, while in the case of cheese it is one of maximum intensity. In addition to the condimental substances above mentioned spices of different kinds are sometimes added. Vinegar is also used at times as a condimental substance and is, to a certain extent, also a preservative substance, but vinegar is chiefly used in the preservation of vegetable substances rather than meats in bulk. For meats which are spiced as well as preserved as above, vinegar is often used as one of the ingredients, intended as a condimental substance. No other substances than those mentioned above are necessary to the proper curing of meat, but convenience of application and certain other considerations have led packers of meats, when not prevented by law, to abandon the old methods to a certain extent and substitute what is known as the quick-aging process described below.

Preservation by Means of Non-condimental Chemical Preservatives.—The use of non-condimental chemicals in the preservation of meat is practically an industry of the last quarter of a century. Up to that time the use of non-condimental chemicals was practically unknown in the meat industry. The chemicals employed are those known as germicides. In the quantities used they neither impart a taste nor odor to a preserved meat, but by their germicidal properties prevent the development of organic ferments and thus make the preservation of meat far more certain and very much less expensive. By the use of some chemicals the salting, sugaring, and smoking of preserved meats may be done with very much less care, in a very much shorter time, and at a very greatly reduced expense. For this reason the practice has gained a great vogue, not as a means of benefiting the consumers, but rather as a means of enriching the packer and dealer. Chemical preservatives are also highly objectionable because they keep meats apparently fresh, while in reality changes of the most dangerous character may be going on. They thus prevent the display of the red light danger signal.

Preservatives Used.—The principal chemical preservatives used in the curing of meats are borax and boric acid and sulfite of soda. There are many other chemical preservatives which have been employed, but these are by far the most useful, the most certain, and the most widely employed. Borax and boric acid, of the two classes, are by far the more common. Sulfite of soda is used more as a preservative of color, and is probably found more frequently on fresh than on preserved meats. Borax has the property of paralyzing fermentative action and thus securing immunity from decay. Its use, however, tends to diminish the palatability of the meat because of its restraining influence upon the condimental method of preservation described above. The meats are more quickly preserved, require less condimental substances, and the borax probably inhibits, to a certain degree, the enzymic action of a favorable kind, described above.

The use of any kind of a chemical preserving agent on meat is most reprehensible, no matter what it may be. Unfortunately, experts differ respecting the influence of these chemical preservatives upon health. The users of chemical preservatives have employed experts of known fame and distinction to testify in favor of these products, while the consumer, perhaps, is not able to go to the expense of securing expert testimony, and, therefore, as respects numbers of witnesses, at least, chemical preservatives have an advantage. In a case of this kind the accused must be considered guilty until proven innocent. It is not sufficient to prove in a given case that borax is not injurious. If it be proven that it is injurious in a single case conviction must ensue. There is no doubt of the fact that the injurious character of borax, even in small quantities, has been fully established, and therefore any amount of testimony to the effect that in individual cases it has not produced injurious results is of no value whatever. If a citizen be robbed and in the course of the prosecution it be shown that there are a million citizens who have not been robbed by this criminal the evidence would be of no value. If it has been shown that the individual citizen has been robbed the prisoner is convicted. No expert would testify that borax has never been injurious,—even those who appear in its favor admit that, but plead that it is generally used in small quantities, and, therefore, cannot be harmful.

The Argument of Small Quantities.—The fallacy of the argument for small quantities is so evident that it needs only to be presented in brief form to show the intelligent and thinking people of this country the fallacy of the claims of experts in favor of chemical preservatives.

The arguments which have been advanced in excuse of the use of preservatives when used in minute quantities have, perhaps, been more vigorously urged for salicylic acid than for almost any other substance. This argument has been urged with such vigor and such ingenuity that a further reference may not be out of place here. The principle which is laid down is that a substance which is injurious to health when added to foods, if not a natural constituent thereof, or if not added for condimental purposes, does not lose its power of injury to health because it is diluted or given in small quantities. The only change which is made is to mask the injurious effects produced—to make them more difficult of ascertainment and impossible of measurement. The fallacy of the argument that small quantities of an injurious substance are not injurious may, perhaps, be best represented graphically. The accompanying chart (Fig. 7) shows theoretically the normal and lethal dose of a food and a drug or, as in this case, a chemical preservative. The chart shows two curves, one representing a chemical preservative and one representing a food. The normal dose of a food is that quantity of food which maintains a healthy adult body in equilibrium. It is represented in the chart on the right by the number 100. If the quantity of food necessary to maintain the equilibrium in a healthy adult body is slightly diminished, no apparent change is at first experienced and possibly even no discomfort. If, however, the quantity of food be still further diminished progressively, as indicated by following the curve down to the left, the point is finally reached when no food is given at all and death ensues, represented by o on the left hand of the diagram designated "Lethal dose." As the curve begins to deviate from the perpendicular on the right the degree of injury is very readily noticed and starvation or symptoms of starvation are set up. Thus if you follow the perpendicular on the right downward to the point 80 the divergence of the corresponding point of the curve is already measurable. As you descend to 0 the magnitude of the measurement increases. It requires but very little further illustration to show how easily the effect of diminishing the normal dose of a food can be measured immediately after the curve begins to vary appreciably from the perpendicular on the right.

Let us now consider the perpendicular on the left, which is marked at the top under the term "Lethal dose," namely, a quantity of the added preservative sufficient to destroy life. The normal dose of such an added chemical preservative is 0 and is shown at the base line to the right, marked

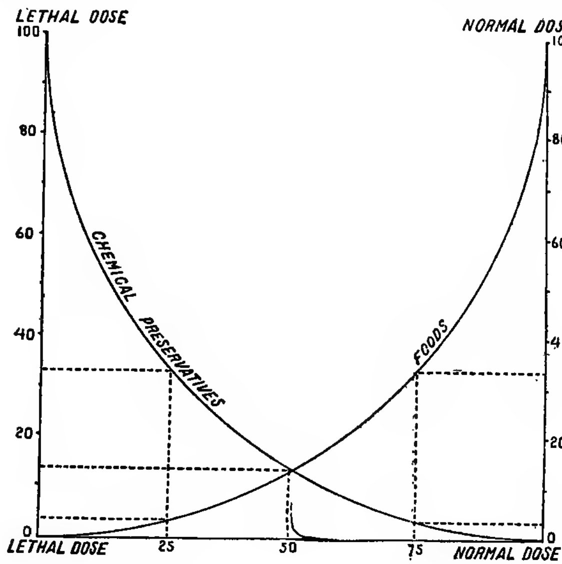


FIG. 7.—GRAPHIC CHART REPRESENTING THE COMPARATIVE INFLUENCES OF FOODS AND PRESERVATIVES.

"Normal dose." If you add a very minute quantity of a chemical preservative, the curve representing it varies so slightly from the horizontal base as to be impossible of measurement by ordinary means. If we follow along to the number 75 on the horizontal base we see the deviation of the curve is sufficiently great to measure. At 50 it is still greater, at 25 still greater, while at the left of the basic line it is a maximum extending from 0 to 100, or the lethal dose. It is easy to show by mathematical data that no matter how small the quantity of an injurious substance or preservative it will still produce an injurious effect which may be infinitely small if the dose be infinitely small. It follows, then, as a mathematical demonstration that any quantity of an injurious substance added to a food product must of necessity be injurious, provided it is in the nature of a drug and the body is in a perfectly healthy, normal condition.

Hence the argument which has been so persistently urged in favor of a chemical preservative, that if in small quantities it is harmless, is shown to be wholly untenable. While there is no necessity for the addition of a harmful substance, where no particular benefit is secured thereby, and where there is no disturbance of the normal state of health, there can be no possible excuse of a valid nature to offer for the exhibition of even minute quantities. That these minute quantities would not be dangerous in so far as producing any fatal effect is concerned is conceded, but that in the end they do not produce an injury even in these small quantities is certainly to be denied. The course of safety, therefore, in all these cases is to guard the opening of the door. If the admission of small quantities is permitted, then there can never be any agreement among experts or others respecting the magnitude of the small quantity, and continued litigation and disagreement must follow. On the other hand, when the harmfulness of any substance which it is proposed to add to food is established and no reason for its use can be given other than the convenience, carelessness, or indifference of the manufacturer, the exclusion of such bodies entirely from food products follows as a logical sequence and a hygienic necessity.

The third method of preparing or preserving meat is by sterilization. Of all the various methods which have been proposed there is probably none which is, theoretically, so free of objections as the preservation of meat by sterilization, in other words, as canned meats. The only important thing is that the raw material used in canning must itself be meat free of disease, obtained under sanitary conditions, and subjected to sterilization before any fermentation or decay takes place. Pure, wholesome meat thus prepared and thoroughly sterilized will remain in an edible condition for a reasonable length of time. Unfortunately, as has has been shown in the testimony respecting the packing industry of the country, canned meats have not always been selected solely for freedom from disease and for palatability. The question of diseased meat is discussed in another part of this book and, therefore, may not be taken up here. There have been used for canning purposes the fragments and, perhaps, inedible portions of carcasses, and this practice cannot be too severely condemned. This does not mean that these fragments and portions of carcasses are not fit for food, but they should be collected, prepared, and sold as such with plain notices to the consumers of their origin. A cheaper supply of beef would thus be furnished for those in humbler circumstances, and no imposition of any kind would be practiced because the nature of the meat would be fully understood.

Preparation of Meat for Canning.—In the following description it is understood that the ordinary processes of canning sound, properly prepared beef are described. The question of the canning of improper samples is reserved for the remarks on adulterations.

There is no uniform practice followed, as has been carefully ascertained by a study of the different packing houses and processes for selecting and preparing meats for canning. The exigencies of trade determine this to a greater or less extent. When there is a demand in the fresh state for all the beef which can be supplied the canning industry will necessarily suffer. When there is a surplus of beef offered for sale or in case of war, where the army contracts for large quantities of canned meat, the opposite conditions probably prevail, and the best meats are used for canning purposes and those of a less desirable quality offered for sale in the fresh state. The portions of the carcass used, as described in Bulletin 13, Part 10, Bureau of Chemistry, depend, to some extent, upon the market of fresh beef. All of the meat on the fore quarter, except the shank and the "third rib," is usually canned, and in some cases those portions are not reserved. The cheaper cuts from the hind quarter are also used for preserving purposes. Very fat, and therefore easily marketed, carcasses are not used for canning purposes except in case of unusual demand as above stated. There are two reasons for this, one of which has already been outlined, namely, that such meat brings a better price in the fresh state, and, in the second place, lean meat has a better appearance in the canned state than the fat meat. For these reasons, in the proper preparation of the meat for canning, the more fatty portions, together with the gristle, are removed and sent to other parts of the factory for making up into other kinds of food.

The meat having been selected, it is cut into pieces of approximately from one to four pounds in weight, according to the size of the tins in which it is to be placed. It is important, for the purpose of appearances, that the size of the pieces of meat in each tin be approximately the same. Also for the process of sterilization the pieces of meat should be practically the same size, so that they can all be thoroughly sterilized at the same time. If the pieces be of different sizes the small ones would become thoroughly cooked and disintegrated before the large ones became thoroughly sterilized, and thus the mass which would be presented to the view on opening the can would be unpleasant to the sight.

Parboiling.—After the pieces have been selected and dressed they are parboiled before being sterilized. The time of parboiling varies in different packing establishments from eight to twenty minutes, according to the size of the pieces of meat. In some cases a uniform time for parboiling is prescribed, irrespective of the size of the pieces. One of the principal reasons for parboiling the meat is to secure the shrinkage, which always takes place on heating, before the meat is placed in the tins.

The experiments have shown that meats when put in tins in a fresh state and sterilized shrink to about two-thirds of their original volume. Parboiling is, in the essence, a process of shrinking. When the meat is put at once into boiling water there is less loss of protein matter than when the meat is placed in cold water and heated gradually. The substances removed in parboiling are water, fat, soluble mineral matter, and the meat bases. The fat is removed by becoming rendered, and rises to the surface where it can be skimmed off. A little over one percent of the protein content of meat is lost by parboiling while the total meat bases lost amount to almost one-third of the total quantity contained in the meat. Of mineral matter in the meat as high as 50 percent is lost in parboiling.

By shrinking, parboiling tends to make a more concentrated article and thus favors transportation. Practically the nutritive value of a pound of properly canned beef is about one-third greater than that of one pound of the fresh beef of the same kind. Hence parboiling may be regarded as a perfectly legitimate and desirable process without which the beef could not be properly prepared for canning.

Tinning.—After the meat is properly parboiled it is placed in the tins either by machinery or by hand. To each tin is added a small quantity of a liquid preparation made by the canners and known as soup liquor. This liquor generally contains salt, and sometimes a little sugar or molasses. The composition of soup liquor is as follows:

Solids,	.92	percent
Protein,	.09	"
Meat bases,	.23	"
Ash,	.28	"
Salt,	.11	"
Water,	98.37	"

This soup liquor may be regarded as a thin soup. The origin of the liquid analyzed above was not disclosed, and, therefore, no expression can be made of the way in which it was formed. It was probably made from soup stock, namely, the waste meat and bones of the factory. There is no objection to a soup liquor of this kind provided it is made from sound, clean, and wholesome material. There are two reasons for adding this liquid, namely, to fill up the space which would otherwise exist between the pieces of meat and thus aid in the preservation of the material, and, second, to add a condimental substance which makes the contents of the tin more palatable.

Sterilization.—After the cans are filled in this way and closed by soldering or otherwise they are placed in retorts which are composed of strong iron or steel boilers, properly covered and secured, and when these boilers are full they are subjected to the action of steam heat under pressure. Usually a small hole is left in the can through which any gas, air or other kind, is expelled from the can. As soon as everything is complete the retorts are opened and the cans are sealed.

In all cases, however, after sealing the cans they are subjected to a second heating at a temperature of from 225 to 250 degrees F. The time of heating varies from one to two hours. After removal from the retorts the cans are washed with a spray of cold water for several hours, and they are then dried, painted, and labeled.

The above is a general description of the process employed which, however, is varied to some extent in different packing houses.

A modification of the above method consists in exhausting the cans in vacuo and automatically sealing them in the exhausted state, thus removing all air and other gases therefrom. The cans are then placed upon an endless conveyor and dipped into an oil bath at a temperature of 240 degrees, the speed of the conveyer being so regulated that the cans remain in the bath a sufficient length of time to complete sterilization before being carried out at the opposite end. After passing through this bath they are carried automatically into another bath consisting of a solution of carbonate of soda and, finally, into a bath of pure water. The cans are then painted and labeled as originally described.

SPECIAL STUDIES OF METHODS OF CANNING BEEF MADE IN BUREAU OF CHEMISTRY.

Composition of Beef Used for Canning.—Samples of fresh beef intended for canning purposes, and examined in the Bureau of Chemistry, have the following composition:

Water,	71.17	percent
Insoluble protein,	13.87	"
Globulins,	1.38	"
Proteoses, peptones, and gelatin,	1.31	"
Meat bases,	1.09	"
Fat,	9.89	"
Ash,	.96	"
Salt,	.04	"
Undetermined,	.33	"

The sample, of which the above data are representative, was secured from a mass of meat weighing 356 pounds, after passing through a sausage grinder and being thoroughly mixed. The class of cattle which are sold under the term "canners" on the Chicago market bring the lowest prices of any edible animals offered for sale. This would indicate that canned beef is not of as good quality as the ordinary beef bought on the market.

Effect of Parboiling.—A similar lot of meat secured in the same way and from the same carcass weighed 358 pounds and was parboiled as follows: The meat was placed in water in a steam-jacketed tank, the temperature of which stood at 196 degrees F. The reduction in the temperature caused by the meat was restored by heating the contents of the retort, and it was kept at 196 degrees F. for 15 minutes. It is thus seen that this parboiling was accomplished at a temperature below the boiling point of water. After the parboiling was completed it was found that the meat weighed 235 pounds, [illegible] This sample of meat was then tinned in two-pound cans with the addition to each can of two ounces of canning jelly of the following composition:

Water,	95.18	percent
Protein,	1.75	"
Common salt,	2.85	"
Ash,	.22	"

After sterilizing, the cans were opened and the contents subjected to analysis. The data obtained are as follows:

Water,	62.47	percent
Total protein,	24.88	"
Insoluble protein,	22.25	"
Proteoses, peptones, and gelatin,	2.63	"
Meat bases,	1.15	"
Fat,	9.87	"
Ash,	.91	"
Salt,	.19	"

Composition of Parboiling Water.—The liquor, after parboiling the above sample, weighed 280 pounds and had the following composition:

Water,	99.12	percent
Protein,	.06	"
Meat bases,	.25	"
Ash,	.25	"
Salt,	.05	"

The above data show that the general effect of parboiling upon the canned meat is to diminish its content of water. Only a small quantity of the soluble proteids is found in the liquor, and the other principal constituents removed, aside from water, are the meat bases and mineral content or ash. The fat in the soup liquor was not determined because it rises to the surface and is not in any sense a constituent of the liquor itself. Considerable quantities of fat were removed in parboiling, the amount depending largely upon the temperature. At a low temperature of parboiling, such as described, the amount of fat secured is far less than when the temperature of parboiling is higher.

TABLE SHOWING THE COMPARATIVE EFFECT OF PARBOILING AND STERILIZING UPON THE FRESH BEEF.

CONSTITUENTS.	FRESH BEEF.	EXTRACTED BY BOILING.	ADDED IN CANNING.	COMPOSITION OF CANNED BEEF AS DETERMINED BY ANALYSIS.
	Lbs.	Lbs.	Lbs.	Lbs.
Water,	254.8	122.1	14.1	146.8
Protein,	59.3	.1	.1	58.5
Meat bases,	3.9	.7	.0	2.7
Fat,	35.4	12.2	....	23.2
Ash,	3.4	.7	.2	2.1
Salt,	.1	.1	.2	.4
Undetermined,	1.2	....	....	1.7
Total,	358.1	....	....	235.4

Preparation of Canned Beef with More Intensive Parboiling.—In another experiment, determining the effect of the changes produced upon the fresh meat, more vigorous preparatory operations were performed. Samples were secured from eight healthy carcasses for use in this determination. Half of the sample was reduced to sausage and secured for analysis as described, and the other submitted to parboiling, sterilizing, and analysis.

COMPOSITION OF THE SAMPLE OF FRESH MEAT.

Water,	69.33	percent
Total protein,	16.81	"
Insoluble protein,	12.69	"
Globulins,	3.06	"
Proteoses, peptones, and gelatin,	1.06	"
Meat bases,	1.12	"
Fat,	10.68	"
Ash,	1.13	"
Salt,	.24	"

The original sample represented over a thousand pounds. The opposite sides of the carcasses were prepared for canning and produced the following amount of articles as sold on the market:

Total weight of half carcasses,	1,761	pounds
3 ribs,	53	"
5 rolls,	43	"
5 loins,	166	"
3 tenderloins,	13	"
3 sirloin butts,	28	"
3 boneless strips,	24	"
8 rump butts,	36	"
8 flank steaks,	8	"
8 kidneys,	9	"
24 beef hams,	261	"
Shank meat,	85	"
Soft bones,	198	"
Shank bones,	107	"
Tank tallow,	132	"
Canning meat,	598	"

The above data show that only about one-third of the whole carcass is suitable for canning purposes. The best and juiciest pieces, it is noticed, are cut away and sold for other purposes. In explanation of the above data it should be stated that only the fore-quarters of the carcass were used and not the whole carcass.

The above is another evidence of the fact that canned meat is not of first-class quality. This, however, does not imply that it may not be made of healthy animals nor that it is not nutritious. The canning of low grade meats tends to raise the price of the higher grades.

Parboiling.—The parboiling of this sample was accomplished in the following manner: The meat was first placed in cold water, 50 degrees F., and heated by means of injected steam. In five minutes the temperature had [illegible] minutes the boiling temperature was reached and continued for one hour. The soup liquor resulting from the parboiling weighed 1,500 pounds and had the following composition:

Water	99.08	percent
Protein	.09	"
Meat bases	.23	"
Ash	.28	"
Salt	.11	"

These data show that, as in the other cases, the chief extraction from the meat during parboiling is water and the next most important removal is of meat bases and mineral matter or ash. After sterilization in the usual way the cans were opened and the canned beef subjected to analysis. The composition of the canned beef was as follows:

Water	56.18	percent
Total protein	31.57	"
Insoluble protein	27.94	"
Proteoses, peptones, and gelatin	3.63	"
Meat bases	1.44	"
Fat	7.72	"
Ash	.82	"
Common salt	.04	"

Composition of the Fresh and Canned Meat.—Below is found a table similar to that already given for the other sample, showing the composition of fresh beef and the resulting canned beef.

Constituents.	Fresh Beef.	Extracted by Boiling.	Added in Canning.	Composition of Canned Beef as Determined by Analysis.
	Lbs.	Lbs.	Lbs.	Lbs.
Water	414.6	243.2	12.9	184.3
Proteins	100.5	1.3	....	101
Meat bases	6.7	3.4	....	4.6
Fat	63.9	39.2	....	24.7
Ash	6.8	4.2	....	2.6
Undetermined	5.5	....	....	2.8
Total	598	....	....	320

From the above table it is seen that the shrinkage during parboiling amounts to 46.49 percent of the weight of the fresh meat. Of this shrinkage 82.85 percent is water, 14.11 percent is fat, 1.51 percent ash, and 0.82 percent meat bases. It is noticed that more than half of the water originally found in the meat is extracted by parboiling.

It seems rather anomalous that boiling a substance with water would extract water from it, but in the case of meats it is seen that half the water, or even more, which a meat contains is extracted from it by boiling in water.

The two samples given are extreme cases in the method of preparing meats for canning. In the first instance the meat is placed at once into hot water just below the boiling point and kept there for only a short time. In the second case the meat is placed in cold water and is brought to the boiling point and maintained there for one hour. In the last case the low temperature of the water in which the meat was originally placed favors the extraction of a portion of the soluble protein matter, namely, albumins, globulins, etc., while, on the other hand, the long-continued boiling to which it was subjected tends to decompose the connective tissues of the meat and causes the loss of small particles of the insoluble protein thus separated by disintegration. Although in the last case the shrinkage was much greater than in the preceding experiment, practically no insoluble protein matter was extracted, mechanically or otherwise.

Canning of Beef without Parboiling.—To determine the amount of shrinkage which takes place and the general effect which is produced by canning meats without parboiling, samples were prepared, sterilized, and canned in the usual way, with the exception of the omission of parboiling. On opening the cans it was found in each case that the meat had shrunk to about two-thirds of its former volume and that the place was occupied by a liquid containing a number of particles of solid matter. The appearance of the sample was much less inviting than that of meat canned after parboiling.

An analysis of the sample was made, with the following results: Total weight of sample, 31 ounces; weight of canned meat, 21 ounces.

Water,	63.83	percent
Protein,	27.25	"
Meat bases,	1.09	"
Fat,	4.62	"
Ash,	1.01	"
Salt,	.04	"
Undetermined,	1.20	"

Composition of Liquid.—The liquid in the can was examined with the following result: Weight of liquor, 10 ounces.

Solids,	6.93	percent
Protein and gelatin,	1.94	"
Meat bases,	1.84	"
Ash,	1.22	"
Salt,	1.15	"

The above data show that the beef lost 32.06 percent of its weight in the canning, a little over half of which is water.

It appears that less protein matter is extracted when the meat is parboiled by being plunged into boiling water than when it is packed in a can without parboiling and subsequently subjected to the temperature of sterilization. In the former case the soluble proteins in meat near the surface are coagulated before they can diffuse into the surrounding water. In the other case, owing to the low conductivity of meat, the temperature at the surface of the can penetrates slowly to the interior and the juices which are extracted from the meat carry with them protein matter in solution which is afterwards precipitated by heat and remains in the liquid as matter coagulated at the temperature of sterilization.

It is seen that parboiling has many advantages. It extracts less of the valuable matter from the meat, it shrinks the meat before packing so that the tins contain more nutrient matter, and it improves the appearance of the meat to the consumer when opened.

Relation of Canned to Fresh Meat.—In the following table is given the number of ounces of canned meat in a number of cans compared with the equivalent amount of fresh beef used in filling them:

No. of Can.	Canned Beef, Ounces.	Equivalent to Fresh Beef Ounces.
1,	29	44.2
2,	29.9	42.6
3,	28.5	38.7
4,	12.6	19
5,	30.5	57
6,	30.6	50.9
Means,	26.9	42.1

It thus appears that a can of 26.9 ounces of beef contains, as an average content, an amount of meat equivalent to 42.1 ounces of fresh beef, and retains practically all of the nutrient value of the larger quantity of fresh beef.

Canned Ham and Bacon.—It seems unnecessary, as a rule, to can ham and bacon properly cured and transported in a suitable manner. There are occasions justifying the use of these products in tropical countries and in other places far remote from the sources of manufacture, and where the preservation of them, by reason of the character of the climate, is difficult.

The proper preparation of these articles, packing in tins and sterilizing, makes it possible to send them to the most distant points and to have them consumed in the most unfavorable climatic conditions. Canned ham, as it is found upon the market, has a higher percentage of fat and a consequently lower percentage of protein than canned beef. The ham is packed closely and the smaller pieces added for the purpose of filling up interstices between the larger pieces of meat and keeping the can full. It is reasonable to infer that the added meat is pork, although very probably it may not always be so.

Composition of Canned Ham and Bacon.—The character of the canned ham and bacon upon the market may be illustrated by the composition of the following samples (these samples were purchased in the open market and are presumably representative of the products as commonly sold in the shops):

COMPOSITION OF CANNED HAM AND BACON.

Description.	Composition of Original Material.														Composition of Dry Material.			
				Nitrogen.				Nitrogenous substances.										
	Water.	Water in fat-free substance.	Fat.	Total.	Coagulated proteids.	Precipitated by bromin.	Meat bases.	Protein (N × 6.25).	Coagulated proteids.	Gelatinoids and proteids precipitated by bromin.	Meat bases.	Ash.	Sodium chlorid.	Total.	Protein (N × 6.25).	Fat.	Ash.	Sodium chlorid
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sliced Star ham,	43.80	71.84	38.22	2.07	1.62	0.06	0.39	12.94	10.12	0.38	1.22	3.86	3.29	97.60	23.00	68.01	6.87	5.85
Boneless ham,	53.30	64.09	16.84	3.75	3.15	.10	.50	23.44	19.69	.62	1.56	5.43	4.34	97.54	50.19	36.06	11.63	9.29
Gold Band sliced ham,	48.27	68.72	29.78	2.82	1.89	.09	.84	17.62	11.81	.56	2.62	5.03	4.10	98.07	34.06	57.58	9.72	7.93
Boneless cooked ham,	41.53	63.50	34.60	3.03	2.50	.12	.41	18.94	15.62	.75	1.28	4.33	3.66	98.25	32.38	59.17	7.40	6.26
Prosciutts Scelto in Fette,	36.77	57.27	35.79	3.05	1.96	.19	.90	19.06	12.25	1.19	2.81	8.37	7.51	97.38	30.12	56.60	13.24	11.88
Lunch ham,	40.74	59.53	31.56	3.68	3.21	.16	.31	23.00	20.06	1.00	.97	3.84	3.08	98.26	38.81	53.26	6.48	5.19
Huckins sandwich ham,	36.56	72.17	49.34	2.04	1.77	.07	.20	12.75	11.06	.44	.62	1.75	. .	99.79	20.13	77.77	2.76	. .
Ham, "Coin Special,"	50.87	69.12	26.42	2.94	2.55	.34	.05	18.38	15.94	2.12	.16	3.55	2.39	99.09	37.37	53.77	7.23	4.86
Sliced Star bacon,	15.34	21.24	27.79	6.68	4.75	.74	1.19	41.75	29.69	4.62	3.72	15.02	13.28	96.28	49.31	32.82	17.74	15.69
Beechnut bacon,	18.59	26.42	29.59	5.74	4.10	.26	1.38	35.88	25.62	1.62	4.31	19.90	17.84	99.63	44.06	36.35	24.44	21.91
Sliced breakfast bacon,	20.73	67.06	69.07	1.07	.92	.07	.08	6.69	5.80	.44	.25	3.06	2.37	99.41	8.44	87.13	3.86	2.99
Gold Band sliced bacon,	19.69	62.99	68.74	1.40	.91	.10	.39	8.75	5.69	.62	1.22	2.57	2.27	98.55	10.87	85.60	3.20	2.83
Fresh pork, rib and loin,	51.80	78.32	33.86	2.15	1.57	.25	.33	13.44	9.81	1.56	1.03	.78	Tr.	98.88	27.87	70.25	1.62	Tr.

Adulteration of Canned Ham and Bacon.—From the above data it is seen that the products are probably true to name, and are actually ham and bacon. The principal adulterations which are found in these articles are preservatives and coloring matters. The coloring matter usually found is saltpeter which, in one instance, was present to the extent of one-tenth of one percent and the average quantity found was one-twentieth of one percent. Saltpeter is not used as a preservative, although it is often claimed by packers that such is the case. In the minute quantities in which it is employed it has little or no effect as a preservative if, indeed, it could be deemed a germicidal substance. The principal preservative which is found is boric acid. In fourteen cases examined, however, only two contained this preservative, which shows that there is no necessity for its use on any occasion. Under the new meat inspection law all meat products prepared for interstate and foreign commerce are packed under direct supervision of the Department of Agriculture and the use of boron compounds is prohibited.

Canned Tongue.—Several varieties of canned tongue are found upon the market known as ox tongue, lamb tongue, luncheon tongue, etc. The tongues of calves, steers, sheep, lambs, and swine are the ones which are usually canned, and they may be previously pickled before canning. The average composition of the canned tongue upon the market is shown from the following data based upon the examination of seventeen samples:

Water,	55.17	percent
Fat,	20.23	"
Protein,	19.43	"
Meat bases,	1.23	"
Glycogen,	.24	"
Total ash,	3.71	"
Of which common salt,	2.90	"

The data show that in the canning of tongue a large quantity of fat is present, more than the true part of the tongue contains. Nearly all of the samples examined contained saltpeter, the largest quantity found being .15 percent.

Adulteration of Canned Tongue.—It is not probable that any meat, except the tongue itself, is used for canning, but the contents may not be true to name. The fat dressing employed is not specified, and probably its character and amount rest alone with the ideas of the manufacturer relative thereto. Presumably the fat should be of the same animal as the tongue. A critical examination of the fat will, however, reveal whether or not this is the case.

Saltpeter is the most common adulteration, and is used solely to impart or preserve the red color of the fresh meat. Boric acid is also occasionally employed. One of the samples contained boric acid.

Without inspection of the process of manufacture, it is not possible to be assured of the sanitary conditions of the meats which are sold as canned tongue and also of the sanitary conditions of the canning itself. These are all matters of the highest importance to the consumer, and should be attested by proper inspection certificates. Under the new meat law only the proper articles can be certified by the officials in charge of inspection.

Examination of Fat as a Test for Adulterations.—It is evident, from what has already been said, that the character of the fats which are used in the canning of preserved meats is not always the same as that of the meat to which they are added. A careful study has been made in the Bureau of Chemistry of the fats extracted from different canned meats. The chemical and physical characteristics of these fats are given in the following table:

Source of Fat.	Melting Point.	Chilling Point.	Iodin Number.	Maumené Number.	Degrees Butyro-refractometer.
	C.°	C.°		C.°	
Canned roast beef, ...	36.5–43.9	27.8–37.0	36.1–50.6	35.6–36.0	47.0–55.5
Canned smoked beef, ...	37.7–41.8	22.0–29.0	50.9–57.5	..	51.0–58.5
Canned ham and bacon,.	23.6–30.5	17.5–24.0	48.5–68.2	39.8–43.5	49.0–58.2
Fowl, ...	28.0–34.0	12.0–36.5	67.0–86.4	38.9–52.0	49.0–62.5

It has been noticed that the crystals deposited by the evaporation of the ether solution of chicken fat resemble beef stearin in shape, but are much smaller and more delicate. It is seen that the melting point of fat in ham and bacon is rather lower than in leaf lard. It is evident, therefore, that this fat is not lard or, at least, not wholly composed of the best lard, but probably consists of the fat not usually employed for lard making.

Potted Meats.—There is found on the market a large number of varieties of potted meat. It is difficult to describe in any scientific way these potted meats because the term "potted" is employed by all manufacturers to describe a mixture of a great many different articles, the exact composition of which is usually a trade secret. There is, apparently, an understanding among manufacturers that the labels of potted goods are not intended in any way to indicate the variety of meat or principal meats contained in the package. In the absence of any trade, sanitary, or chemical standard it is difficult to make any just criticism of the character of the potted goods upon the market.

The principal object of mentioning them here is to inform the consumer of the probable character of the potted goods which he may consume, and to let him understand that it is by no means certain that the name of the meat upon the label describes the character of the meat which he is actually eating. The chief object in the manufacture of potted meat is to make a supply of uniform character and consistency, and properly spiced and flavored to attract and hold the patronage of the consumer.

A certain degree of consistency is established by each manufacturer for each variety of potted goods made, and to obtain this consistence more or less fat meat of some kind is added. It may thus be of some advantage to add the fat of pork rather than the fat of beef or mixtures of the two. It is claimed by many manufacturers that a single kind of meat does not give the desired flavor in potted and deviled goods. Therefore, meats of different origin are finely ground and mixed together, and a sufficient quantity of oil or fat added to secure the required physical consistence. For this reason cured meats, such as beef and pork, are often preferred for making potted and deviled meats because of the agreeable flavor and aroma which they impart thereto. These meats are therefore used in potting, although they cost more than corresponding quantities of fresh meat. In a character of goods so variegated as these it is impossible to lay down any rule which may guide the consumer in his choice. The widest latitude is left to the manufacturer, and the only real protection is in a strict inspection of the factory or factories where such goods are made. It is there only that the character of the materials employed and the quality of the condiments or other substances added can be determined. The day is doubtless rapidly approaching when consumers will be perfectly protected in this matter, and when no canned, potted, or deviled meats of any description will be allowed to enter into commerce without bearing the certificate of competent inspection officers as to the kind of meats used, their sanitary character, etc.

Potted meats should always be carefully sterilized and the contents of the tins should be consumed as soon as possible after they are opened.

Potted Beef.—Potted beef corresponds more closely to the character of the meat named on its label than do any of the other potted products. Of four samples of commercially potted beef examined in the Bureau of Chemistry only one appeared to contain any other meat than beef. The composition of the potted beef is shown in the table on page 53.

Adulteration of Potted Beef.—From the following average data it is seen that the principal adulteration in potted beef, assuming that the meat is beef, is starch. Two of the four samples contained starch, one more than 14 percent and one more than 11 percent. The admixture of starch is evidently solely for fraudulent purposes, to increase the weight and bulk with a very much cheaper substance and one for which no necessity for the addition can be claimed. It also increases the quantity of water which the product will carry. Saltpeter was found in one of the four samples and boric acid in two. One of the samples contained a large quantity of tin, due probably to the action of the potted meat upon the tin lining of the can.

Potted Deviled Meats.—The term "deviled meat" is applied to a mixture of finely ground meat with spices, condiments, and other substances, and, like the term "potted," is used rather to indicate a miscellaneous mixture than any single compound.

All that has been said respecting the composition of potted meat applies

COMPOSITION OF POTTED BEEF.

Samples.	Composition of Original Material.																	Composition of Dry Material.			
	Water.	Water in fat-free substance.	Fat.	Nitrogen.		Nitrogenous substances.				Starch.	Glycogen, calculated to dry, fat-free material.	Saltpeter.	Total ash.	Sodium chlorid.	Heavy metals per kilogram.	Preservatives.	Total.	Protein (N × 6.25).	Fat.	Ash.	Sodium chlorid.
				Total.	Meat bases.	Protein (N × 6.25).	Proteids insoluble in hot water.	Gelatinoids and proteids precipitated by bromin.	Meat bases.												
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Milligrams.*		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	28.24	50.33	43.89	3.76	0.56	23.50	19.50	0.50	1.75	...	0.32	0.05	3.31	2.43	Tin . . 145.1	None	97.24	32.75	61.19	4.61	3.39
2	51.80	64.40	19.58	...	...	...	...	...	...	14.26	...	...	...	...	...	Boric acid	...	...	40.62	...	...
3	54.92	62.20	12.70	2.87	.64	17.94	12.88	1.06	2.00	11.56	.22	...	4.50	...	...	do	99.69	39.81	28.17	9.98	...
4	65.51	72.92	10.26	3.14	.42	19.62	15.06	1.94	1.31	...	.25	...	2.30	...	...	None	96.44	36.88	29.75	6.67	...

with equal force to deviled meat. If there be any difference at all it is understood by the term deviled that the spices and condiments are more pronounced in character and greater in quantity and the miscellaneous character of the goods more pronounced. Under the terms of "deviled" and "potted" may be found every kind of mixed and miscellaneous finely comminuted meat, flavored with all kinds of condimental substances and prepared so as to appeal as strongly as possible to the taste and desire of the consumer.

It may be said, in connection with these goods, that there is no objection whatever to their manufacture and sale provided the meat used in their preparation is sound and sanitary, the conditions of manufacture clean and free of infection, and provided the fraudulent additions for the purpose of increasing bulk and weight are excluded, together with injurious preservatives and coloring matters, such as borax, saltpeter, sulfite of soda, etc.

Potted and deviled are not the only terms, however, which are used to express miscellaneous mixtures of meat products. The term "pâtés" is also employed for a large class of goods, among which the principal ones are the familiar pâtés de foie gras, which should be made largely of fatty goose livers.

Composition of Pâtés.—The result of the examination of large quantities of pâtés in the Bureau of Chemistry indicates that they are made up principally of the meat of beef and pork. It is not quite certain in any of the cases that the highly prized livers of fat geese have been employed to any considerable extent. There are no forms of comminuted meats of any description which are so objectionable in name as those that are sold under the name of pâtés, especially when they are ascribed to a particular composition, as is the case with pâté de foie gras. As has been remarked before, there is certainly no objection to the manufacture of these mixtures, but misleading statements concerning them are to be condemned. The manufacturer and consumer of pâté de foie gras should establish some standard of the percentage of goose livers which they should contain, and each package should be accompanied by an official certification that it has been inspected and found to be up to the standard. It is only in this way that the public can be protected against fraud and imposition. Where no descriptive word at all is used with the word pâté there is no reasonable limit to be placed upon the kind of meat used, provided it is of a sound and sanitary character. The term pâté itself means a mixture and, therefore, it is no deception and imposition upon the public to sell a pâté of a miscellaneous character, provided it does not bear any false statement regarding origin or character.

The mean composition of forty-three samples of pâtés and purées is found in the following data:

Water,	45.87	percent
Water in fat-free substance,	71.18	"
Fat,	35.41	"
Protein,	11.92	"
Meat bases,	.82	"
Starch,	7.44	"
Total ash,	2.88	"
Of which sodium chlorid,	.97	"

From the above data it is seen that the pâtés are characterized by a very high percentage of fat and a correspondingly low percentage of protein. A very large majority of the samples examined contained starch, the highest quantity found being 15.80 percent. Only two of the samples were found to contain saltpeter; six contained boric acid and three benzoic acid. Tin and zinc were found in a few cases.

Principal Adulterations of Mixed, Miscellaneous, Potted, Deviled, and Comminuted Meats.—As has been observed in the analyses of the commercial articles which have been submitted it is evident that no detection of the adulteration of these minced meats with impure, fragmentary, diseased, or unwholesome articles is possible in so far as chemical analysis is concerned. A microscopic analysis also often fails to reveal the true character of the meats which have been used in the preparation of these products. Hence the adulteration of these goods with diseased, unwholesome, unfit, and unsanitary meats cannot be controlled nor even positively affirmed after the meats are prepared and canned. Such adulterations are doubtless frequent and are the most objectionable. The only protection to the consumer is in a certificate of inspection before preparation and packing. The consumer, by refusing to purchase such comminuted meats in the absence of such a certificate, would soon compel the manufacturer to secure official inspection and certification of his products.

Adulteration with Starch.—One of the chief adulterants in sausages and prepared meats is starch. It has been said by some hygienists that starch is not an objectionable adulterant on hygienic grounds. This, however, is not strictly true. The injection of large quantities of starch into meat tends to unbalance a ration which is fixed with certain quantities of other food and tends to increase the proportion of starchy matter therein. There are many conditions of disordered digestion in which such increases of starch, unknown to the physician or patient or even known, are highly objectionable. Hence the use of starch as an adulterant in meat of this kind is reprehensible on hygienic grounds. The principal purpose for using starch is deception. Starch increases the bulk and weight of goods, and, in the process of cooking, prevents undue shrinkage. The consumer, therefore, thinks that he has secured a larger quantity and better quality of meat than he really has, and is, to this extent, defrauded and deceived.

Preservatives.—The preservatives which are principally used in meat are borax, boric acid, sulfite of soda, and benzoic acid. All of these preservatives have been shown, by the work of many investigators, to be deleterious to health. They should be rigidly excluded from all meat as well as other food products.

Coloring Matter.—Dyes are frequently used for coloring sausage and other minced meats. All such dyeing materials are reprehensible, both on account of the danger to health and deception. Preserved meats gradually lose the natural red tint of the fresh meat, and to that extent the color is an index of the time during which they have been preserved. Inasmuch as consumers prefer fresh meats preserved as short a time as possible, they are deceived and to that extent injured by the use of dyestuffs which impart to preserved meats a fresh appearance.

Indirect Coloring Matter.—Certain chemicals, which of themselves have no color, serve to fix and hold, or even accentuate, the natural color of meat. The two principal chemicals used for this purpose are saltpeter and sulfite of soda. Saltpeter is used generally in preserved meats to retain and accentuate the red color thereof. Sulfite of soda is used principally on fresh meats, where it acts both as a preservative and as a retainer of color. Sprinkled over the freshly cut surface of fresh meat, sulfite of soda preserves the red tint, and the customer thinks it has just been cut. In this way he is deceived. Both of these substances are highly objectionable not only on account of deception but on account of being injurious to health. In the case of saltpeter, the general opinion concerning its therapeutic action is that it is not a proper substance to mix with foods. It is no more than fair to the consumer, therefore, for the packer, if he deems it necessary to use bodies of this kind, to plainly state upon each package the character and quantity of preservatives and coloring matter employed. The consumer is then left to judge for himself whether or not he desires to eat these bodies.

The principal objection to notifications of this kind is that the consumer, not being an expert as a rule, cannot form any intelligent opinion respecting the desirability of these substances in food. He is more apt to be guided by common practice in this matter and by his own opinion than by any general principles of chemistry and hygiene.

Potted Tongue.—The term "potted tongue" may apply equally to tongue of a single character, such as beef, lamb, pork, or swine, or the mixture thereof. The examinations which have been made of the potted tongues of commerce do not indicate whether they are of a single character or whether the tongues are derived from a variety of sources. The mean composition of twenty-one samples bought in the open market, as found in the Bureau of Chemistry, is given in the following table:

Water,	52.50	percent
Water in the fat-free substance,	67.67	"
Fat,	22.99	"
Protein,	17.80	"
Meat bases,	.75	"
Total ash,	5.46	"

Adulteration of Potted Tongue.—In the samples examined above starch was found in four cases, the largest amount being 11.6 percent. Saltpeter was found in eighteen cases, the largest amount being .06 percent. Tin was present in thirteen cases and zinc in eight cases. Boric acid was found in fourteen cases.

From the above it is evident that the principal adulterations in potted tongue, aside from the use of meats which are not tongue, and which chemical analysis cannot disclose, are the addition of starch, saltpeter, tin, and zinc, the two latter derived either from the solder or from the can in which the goods are placed.

Canned Poultry.—Other fresh meats, in addition to beef and pork, are canned in a fresh state. In the case of poultry the fowls are dressed and drawn and the whole carcass boiled until the meat is sufficiently cooked to facilitate the separation from the bones. The bones are then removed and the meat is canned and sterilized by practically the same method as practiced with canned beef. Game and wild fowl meats are also subjected to the same process of canning as the domesticated chickens, geese, ducks, turkeys, etc. In general it may be said that there are no differences in the processes employed, but the important question to the consumer is the character of the raw materials used, the sanitary conditions which attended their preparation, and their freedom from admixtures of other meats cheaper in price and of different dietetic values.

Adulteration of Canned Fresh Meat.—Fortunately the process of sterilization is of such a character, when properly carried out, as to exclude all necessity for the addition of any preservative substances to canned fresh meat. The use of ordinary condimental substances in moderate quantities cannot be regarded as an adulteration. Hence, the addition of small quantities of salt, sugar, vinegar, and the ordinary spices, when used solely for the improvement of the taste and flavor and not for preservative purposes, is regarded as unobjectionable.

The common preservatives used in canned meat are, first, those which give color to the meat and preserve its natural red tint. For this purpose saltpeter and sulfite of soda are most commonly employed. Red dyes of any description are rarely, if ever, found. The preservative which is used most frequently in canned meat is borax or boric acid. That this use is not necessary is evident from the investigations which have been made by many investigators which show that in most cases no preservatives at all are used. The addition of any chemical preservative is, therefore, to be regarded as unnecessary and as an adulteration.

The use of any diseased, tainted, decomposed, or filthy meat, even if it is of the same origin as that in the can, is an adulteration of the most serious character and one that can only be effectually controlled by the inspection mentioned. The adulteration of the meat of fowls of all descriptions by cheaper meats, such as pork or veal, even if they be of wholesome and sound character, is an adulteration said to be often practiced and one which it is difficult to detect if the particles of meat are finely comminuted.

Standard for Preserved Meats.—The standard for preserved meat is the same as that for fresh meat which is given in Circular 19, Office of the Secretary, U. S. Department of Agriculture. The meat must be sound, wholesome, clean, freshly taken from the slaughtered animal, and not from one that has died from disease, suffocation, or accident, and must conform in name and character to the meat of the animal.

Frequency of Adulteration.—The examination made of numerous samples of canned meat by many investigators shows that the adulteration of these foods is rather common but by no means general.

Canned Horse Meat.—Horse meat is commonly used for human food in many European countries, although it is believed that it is not used to any extent in the United States. When procured from healthy animals in a proper way there is no hygienic objection to its use, though it is considered to be somewhat tougher than the flesh of other animals more commonly employed as food, but that is probably due to the fact that horses are not raised for food purposes and are usually not used for such until they are worn out in domestic service. There are many sentimental and often religious objections to the use of horse meat, but experience has shown that it is wholesome and nutritious. Horse meat is characteristic in containing more natural sugar, commonly known as glycogen, than any of the other ordinary meats used for human consumption. It approaches in its content of sugar some of the shell-fish flesh, such as that of the lobster. Practically all of the horse meat which is prepared in this country is exported to Europe. There are cases, however, on record of the sale of horse flesh to domestic consumers. Especially could it be used in this way in the form of sausage or other finely comminuted products without much danger of detection.

Composition of Horse Meat.—A number of samples of horse meat of undoubted origin and wholesomeness have been examined in the Bureau of Chemistry and the data tabulated. The average composition of sixteen samples of horse meat, representing different parts of the carcass, is shown in the following table:

Water,	69.81	percent
Water in fat-free substance,	76.91	"
Fat,	9.61	"
Protein,	19.47	"
Protein insoluble in water,	14.83	"
Gelatinous protein,	1.23	"
Meat bases,	1.70	"
Glycogen,	1.82	"
Ash,	1.01	"

Composition of Dry Material.—

Protein,	67.98	percent
Fat,	27.71	"
Ash,	3.18	"
Undetermined,	1.13	"

The high percentage of glycogen in horse meat is one of the safest methods of determining its character when comminuted or cut up into pieces so small as not to be identified by the usual anatomical characteristics. Very few other kinds of edible flesh contain as much as one percent of glycogen. Glycogen is a transitory product which tends naturally to be broken up into other substances, and, hence, even in horse meat after slaughter, it may rapidly disappear and thus, unless the meat is examined at once, very little glycogen may be found in it. A safer test for horse meat is in the nature of the fat therein. This fat does not tend to change as the glycogen does, and, therefore, in a pure preparation of horse meat even in a finely comminuted state the separation and examination of the fat will lead to a determination of the character of meat employed. The fats of horse meat have a lower melting point, a higher iodin number, and a higher heat value when mixed with sulfuric acid than those of beef.

Indeed, these differences are so marked as to afford a ready means of detection to the practical chemist. Even in the mixture of horse meat with other meat the variation in the character of the fats will be such as to lead to a correct judgment respecting the approximate amount of horse meat which has been used, provided it forms any notable amount of the mixture.

Canned Cured Meats.—Sterilization is such a certain method of preventing the decay of meats that it has now come into use to a large extent in the final preservation of shipments of cured meats. The object of curing, as has already been stated, is not merely to prevent the meat from decaying, nor is it intended to inhibit entirely enzymic action. On the contrary, if the method of curing were such as to entirely stop fermentative action, the flavors and aromas of preserved meats, upon which their value so much depends, would be eliminated, and we would simply have a mass of tasteless meat, preserved from decay by the application of chemical preservatives of a character to impart neither flavor nor aroma to the meat and at the same time prevent the activity of the various ferments above described. Such methods of preparation, naturally, should never be of general use, because in cured meats the consumer demands the flavor which naturally proceeds from the ordinary method of curing. After curing and when subjected to transportation the meats may undergo decomposition and reach their destination in a spoiled state. To avoid this it has been a customary practice to pack the meat in a chemical preservative, such as borax. This is, however, a very objectionable practice because even in the cured state the meat is still absorptive, and the borax, which is packed externally upon it, as a precaution during transit, must necessarily penetrate to a certain extent to the interior of the meat. By packing cured meat in tins and subjecting these tins to sterilization complete immunity from decay may be secured and there is no damage done to the aroma or flavor. We, therefore, find upon the market at the present time in tinned, canned, or potted form almost every variety of meat that is used either in a fresh state or after the usual method of curing.

Canned Sausage.—One of the most important of cured meats which is offered for sale is sausage. Sausage may be canned either in the fresh or cured state and, of course, may be adulterated in both conditions. Canned sausage should have a clean bill of health from the local inspector the same as any other meat food.

There is, perhaps, more room for deception in the manufacture of sausage than in almost any other form of comminuted meat. When properly treated with condimental substances, such as salt, spices, vinegar, etc., sausages are highly prized as a food product, and justly so. In the canned state sausage should undergo no other manipulation than spicing and sterilization at a temperature necessary to kill all fermentative germs and prevent decay.

Composition of Canned Sausage.—Twenty-five samples of canned sausage examined in the Bureau of Chemistry had the following average composition:

Water,	58.51	percent
Water in fat-free substance,	75.59	"
Fat,	21.82	"
Protein,	13.92	"
Protein insoluble in water,	11.37	"
Gelatinous protein,	1.21	"
Meat bases,	.67	"
Ash,	2.86	"
Sodium chlorid,	1.02	"

The above data show that canned sausage differs largely from fresh meat in its composition, especially in the much higher content of fat and lower content of water which is found therein.

Adulteration of Canned Sausage.—The principal adulteration, as has already been stated, is in the admixture of meats of unknown and miscellaneous origin and possibly inedible in character. The degree of comminution to which sausage is subjected renders it difficult in the inspection of sausage itself to determine the character of the animal from which it is made. The study of the fat is the most useful guide in such cases. Presumably sausage is made almost exclusively of beef and pork, but, as a matter of fact, much which is not eaten under its own name may be found in sausage.

Next to the introduction of meat of an improper character the most important adulteration is the common use of starch. Starch is very much cheaper than meat, and its abundant use enables a greater profit to be made. It is highly esteemed, also, as a "filler," on the ground that it prevents the shrinkage of sausage when fried. Starch granules under the influence of heat are gelatinous, holding moisture with tenacity and preventing shrinkage in bulk.

The presence of starch in sausage must be regarded as an unjustifiable adulteration unless the amount therein is plainly marked on the label of the package.

The use of preservatives in the curing of sausage is a very common practice and, hence, canned sausages are found to often contain boric acid or borax and sulfite of soda especially. Dyes of various kinds are also used in coloring sausage or its covering, largely of a coal tar origin.

The proper safeguard for the consumer in regard to the character of sausage is in the inspection of the factory. It is highly important that each municipality and state should have a rigid system for the inspection of sausage, and the sausage thus inspected should bear the certification of the kind of meat used and its general character. The presence of inspectors in factories would prevent the use of preservatives which, it has been shown by the researches of many investigators, are prejudicial to health.

Magnitude of the Meat Industry.—According to the census of 1905, there has been a large increase in the slaughtering and meat packing industry in the United States, as compared with the statistics of 1900. The data for the Census of 1910 are not yet available. Owing to the extension of the meat inspection service there are now 876 establishments in 240 cities and towns under inspection. The number of animals submitted to ante mortem inspection in 1909 was 56,545,737 and to post mortem inspection 55,672,075. Of this latter number 141,057 were condemned.

Comparative figures for 1905 and 1900 are shown in the following summary:

	1905.	1900.	Percent of Increase.
Number of establishments,	929	921	.8
Capital,	$237,699,440	$189,198,264	25.6
Salaried officials, clerks, etc.:			
Number,	12,075	10,227	18.0
Salaries,	$13,377,908	$10,123,247	32.1
Wage-earners:			
Average number,	74,132	68,534	8.2
Wages,	$40,447,574	$33,457,013	20.9
Miscellaneous expenses,	30,623,108	24,060,412	27.3
Materials used:			
Total cost,	$805,856,969	$683,583,577	17.9
Animals slaughtered:			
Beeves,	$289,040,930	$247,365,812	16.8
Sheep,	44,359,804	37,137,542	19.4
Hogs,	329,763,430	278,736,961	18.3
Calves,	12,666,942	7,356,560	72.2
All other,	61,905	559,839	
All other materials,	129,963,958	112,426,863	15.4
Products:			
Total value,	$913,914,624	$785,562,433	16.3
Beef—			
Sold fresh,	$247,135,029	$211,068,934	17.1
Canned,	7,697,815	9,167,531	17.1*
Salted or cured,	8,107,952	9,661,834	16.1*
Mutton—			
Sold fresh,	$36,880,455	$32,963,219	11.9
Veal—			
Sold fresh,	$12,856,369	$7,812,714	64.6
Pork—			
Sold fresh,	$91,779,323	$84,019,387	9.2
Salted,	116,626,710	88,674,016	31.5
Hams, smoked bacon, etc.,	132,210,611	148,666,859	11.1*
Sausage, fresh or cured,	25,056,331	21,472,413	16.7
All other meat sold fresh,	9,579,718	7,813,078	22.6
Refined lard,	74,116,991	52,620,348	40.8
Neutral lard,	8,423,973	8,588,350	1.1*
Oleomargarine oil,	10,201,911	11,482,542	11.2*
Other oils,	2,595,951	3,440,358	24.5*
Fertilizers,	4,397,626	3,300,132	33.3
Hides,	44,137,802	33,925,911	30.1
Wool,	5,229,521	3,335,824	56.8
All other products,	76,880,536	47,548,983	61.7

* Decrease.

GENERAL OBSERVATIONS.

It is evident, from the foregoing description of the methods of preparing and sterilizing meat, that it is a process which commends itself both on account of the economy in the use of meat which it secures and because of the nutritive value of the products obtained.

The real value of the products must necessarily depend upon the selection of the raw materials and the sanitary conditions which attend their manipulation. Experience has shown that it is not safe to leave these matters to the packers themselves. While, doubtless, the greater number of packers will exercise all possible care in the selection of the materials and in their preparation, human nature is of such a character that when opportunity for deception, fraud, and illegitimate gains are presented there are always some who take advantage of them. Hence, it may be safely said that no tinned or canned or sterilized meat of any description should be allowed to enter into consumption except when prepared under the inspection of qualified municipal, state, or national officers. The health of the animal furnishing the meat should be ascertained by inspection both before and after slaughter. This inspection should be of the most rigid kind, and all diseased animals should be excluded from entering into standard products. If it be claimed that there are certain diseases which are local only in character and which do not affect the wholesomeness of the whole carcass, special provisions can be made for this kind of meat. If admitted into consumption at all, it should be under a permanent label or tag by which the intended consumer would be informed of the character of the contents of the package.

There is a reasonable doubt respecting the suitability for human food of carcasses of animals afflicted in a moderate degree with tuberculosis, pleuropneumonia, lumpy jaw, or other contagious or epidemic diseases. In all such cases the rights of the consumers demand that the benefit of the doubt should be given to them and not to the owner, manufacturer, and dealer in any of the products they consume. Such meat would then enter the market under a separate grade and command a lower price, and when consumed no one would be deceived respecting its character.

It must be admitted, even if such meat be regarded as wholesome, that it is of inferior character, and cannot in any justice demand the right to pass under the name of higher grades of the article. The sanitary conditions under which such meats are prepared are of the highest importance. The slaughter house should be clean, and provided with good ventilation and natural light. The workmen should be free of disease, neatly dressed, and required to observe all necessary sanitary precautions. The débris and fragments of the packing house should be carefully removed and so disposed of as to prevent any suspicion that any part of them enters any of the products of the factory. Municipal, state, or national inspection should be frequent, thorough, and entirely removed from any possible influence of the packing business itself. Competent veterinary experts should pass upon the state of health of each carcass, and any one found diseased in any way should be subjected to a further careful inspection to see whether it should be admitted, under proper label and notification, as human food or consigned to the fertilizer heap. It is only by such inspection as this that the consumer can secure adequate protection. After the meat is once in the can inspection will only reveal whether or not preservatives and coloring matter have been used, or whether the contents of the can are spoiled or in a state unfit for consumption. No examination of the contents of the can will reveal in a satisfactory manner the state of health of the carcass from which the meat has been secured or the sanitary conditions under which it has been prepared. It is hoped the new methods of inspection established by the Secretary of Agriculture will secure the desired purity of meat products.

LARD.

The fat of swine, properly separated from the other tissues, is known as lard. The process of separation is termed "rendering." Various methods of rendering are practiced, all depending, however, upon the use of heat, which liquefies the fat and gradually frees it from its connective tissues.

Parts of Fat Used for Lard Making.—In the making of lard the highest grades are produced from the fat lining the back of the animal and that connected with the intestines. The sheets of fat which are found lining the back of the animal furnish a variety known as leaf lard. All parts of the fat of the animal not used in the meats themselves may be used in the manufacture of lard. In the preparation of the carcass, the parts cut off in trimming the pieces and containing fat are sent to the rendering tank. The leaf lard is also removed by tearing it off from the back of the animal, and the intestinal fat is separated from the viscera in like manner. There is probably no question of wholesomeness between the lards made from different parts of the carcass. The lard differs in its chemical composition and its physical consistence as determined by its location in the body. Inasmuch as it is important that lard should have a certain degree of consistence even in summer time and not become too soft or liquid in character, the lard which has a high melting point is preferred, especially during the summer. The lards made from the feet and some other parts of the hog have lower melting points. The different kinds of fat from all parts of the animal might be mixed together and a lard made therefrom representing the average consistence of the fat of the whole body. A small quantity of stearin is often added to raise the melting point, but the addition of this substance without notice must be regarded as an adulteration.

Names of Different Kinds of Lard.—The names applied to the different kinds of lard may be referred principally to the parts of fat used, such as leaf lard, intestinal lard, etc., or to the method of preparing it. The old-fashioned method of preparing lard for family use consisted in placing the fat in an open kettle and heating usually over the open fire. The rendering takes place as the mass increases in temperature, so that the residual tissues become browned by the high temperature reached. Lard made in this way is of most excellent quality and, of course, being made under family supervision, its character is well understood and the parts of the body used are well known. In the large packing establishments the lard is usually rendered by the application of heat in the form of steam under pressure, of a suitable temperature to make the character of the lard uniform. Large yields can be secured in this way with less charring of the residual tissues, and consequently the lard itself is a finer and whiter product. Lard of this kind is sometimes known as steam rendered lard.

Uses of Lard.—The fat of swine prepared as above mentioned, and known as lard, finds a very extended use in every kitchen. It is mixed with various forms of bread making materials, cake, etc., and is often known in this sense as "shortening." It is also employed for lubricating the pans and other culinary utensils used for baking purposes. It is sometimes employed for the purpose of cooking by the process of frying or of introducing the substance to be cooked directly into the hot lard, as in the frying of oysters, the making of doughnuts, and similar operations. Lard has come to be looked upon as a necessity in every kitchen, even of the humblest citizen.

Many objections are made to the use of lard on hygienic grounds, and probably on account of its cheapness and general utility it is more freely used in American cooking than it should be. In other words, American cooking is under the reproach of being too greasy. There is no reason to question the digestive and nutritive value of lard when used in proper quantities and in proper conditions. It is a typical fat food composed of materials which are almost wholly oxidized in the body and which upon combustion produce a higher number of units of heat than that of any other class of food substances.

COMPOSITION OF DIFFERENT VARIETIES OF AMERICAN LARD.

	Specific Gravity.	Saponification Equivalent.	Melting Point.	Melting Point of Fatty Acid.	Crystallizing Point of Fatty Acid.	Rise of Temperature with Sulfuric Acid.	Iodin Absorbed.	Water.
			C.°	C.°	C.°	C.°	Percent	Percent
Leaf lard, ...	.9057	272.64	41.6	43.0	40.40	39.7	59.60	.165
Pure leaf lard, ...	.9028	281.01	44.9	42.8	40.40	37.1	53.04	.025
Prime steam lard, ..	.9052	279.06	38.4	41.8	39.53	33.7	63.84	.040

Adulteration of Lard.—The principal adulteration to which lard is subjected is admixture with other and cheaper fats. Among the fats which are used for this purpose may be mentioned beef fat and cottonseed oil. Beef fat has a higher melting point than lard and cottonseed oil a much lower melting point, being liquid at ordinary temperatures. A mixture of beef fat and cottonseed oil may, therefore, be made, having approximately the same melting point as lard itself. The addition of this mixture to lard would not alter its melting point to any sensible extent. Instead of using the whole cottonseed oil for the purpose mentioned it may be previously chilled and its product of a higher melting point, or as it is sometimes called, the stearin of cottonseed oil, may be used for admixture with lard. Large quantities of these mixed fats were formerly made in this country under the name of "compound lard" in which the above adulterants were the chief constituents. The laws of the various states are happily of a character which forbids the sale of a mixture of a compound of lard and other fats under the name of lard, although there is no objection to such admixture from a hygienic and dietetic point of view. There are many hygienists who are of the opinion that the more extended use of vegetable oils instead of lard would be of value to the health of the public. If this be true, the admixture of a vegetable oil with lard would improve it from a hygienic standpoint. The principal, perhaps the sole, objection to such admixtures is their fraudulent character. Vegetable oils, especially cottonseed oil, being very much cheaper than lard, their use in lard without notification cheapens the product and defrauds the customer. Lard may also be adulterated with its own stearin. In the manufacture of lard oil a residue is left of a much higher melting point and this residue may be mixed with a vegetable oil, such as cottonseed, in the production of a compound of approximately the same melting point as lard itself. In a case of this kind both constituents are fraudulent, in as much as neither the cottonseed oil nor the lard stearin may be regarded in any sense as lard.

Detection of Adulterations.—The presence of cottonseed oil in any form in lard is at once determined by the application of a simple color test known as the Halphen test. This is not a reliable test in those cases where the animal has been fed cottonseed.

Halphen Reaction for Cottonseed Oil.—Carbon disulfid, containing about one percent of sulfur in solution, is mixed with an equal volume of amyl alcohol. Mix equal volumes of this reagent and the oil under examination and heat in a bath of boiling brine for fifteen minutes. In the presence of as little as one percent of cottonseed oil an orange or red color is produced, which is characteristic.

Lard and lard oil from animals fed on cottonseed meal will give a faint reaction, as will also the fatty acids thereof.

This test is more sensitive than the Bechi test (nitrate of silver) and less liable to give unsatisfactory results in the hands of an inexperienced person.

It is not affected by rancidity. The depth of color is proportional, to a certain extent, to the amount of oil present, and by making comparative tests with cottonseed oil some idea as to the amount present can be obtained, but it must be remembered that different oils react with different intensities, and oils which have been heated from 200° to 210° C. react with greatly diminished intensity. Heating ten minutes at 250° renders cottonseed oil incapable of giving the reaction.

Cottonseed oil also has the property of reducing silver in silver nitrate to a metallic state. When mixed with a solution of silver nitrate under proper conditions a blackening or precipitation of black metallic silver is observed. This is known as the Bechi test which is conducted as follows:

Bechi or Silver Nitrate Test for Cottonseed Oil.—Reagent: Dissolve 2 grams of silver nitrate in 200 cubic centimeters of 95 percent alcohol and 40 cubic centimeters of ether, adding one drop of nitric acid.

Mix 10 c.c. of oil or melted fat, 5 c.c. of reagent, and 10 c.c. of amyl alcohol in a test tube. Divide, heat one-half in a boiling water bath for ten minutes, and then compare with portion not heated. Any blackening due to reduced silver shows presence of cottonseed oil.

Other oils which have become rancid, and lards which have been steamed or heated at high temperature, contain decomposition products which have a reducing action on silver nitrate. There were found in testing a large number of salad oils some which contained no cottonseed oil, according to the Halphen test, but gave a brown coloration with Bechi reagent, and in some cases reduced silver. These same oils on being purified gave no reaction. Hence the oils or fats should be purified before testing.

To purify the oils and fats, heat from 20 to 30 grams on water bath for a few minutes with the addition of 25 c.c. of 95 percent alcohol, shake thoroughly, decant as much of the alcohol as possible, and wash with two percent nitric acid, and finally with water. The oil or lard thus purified will give no reduction at all if it contains no cottonseed oil. Heating the oils or fats to 100° C. or simple washing with two percent nitric acid is not sufficient, except in a few cases.

With oils the use of the Halphen and Bechi tests will be found to be useful as a means of approximately determining the amounts of adulteration present. If Halphen gives a reaction and Bechi does not, the adulteration with cottonseed oil is probably less than 10 percent.

The admixture of beef fat with lard is best detected by means of the microscope. The fat is dissolved in ether and allowed to slowly crystallize. If it is composed of pure lard the crystal assumes a form which is represented in Fig. 8.

If, on the other hand, beef fat be mixed with lard, the crystals will assume a radiated fan-shaped appearance shown in Fig. 9. Even one who is an

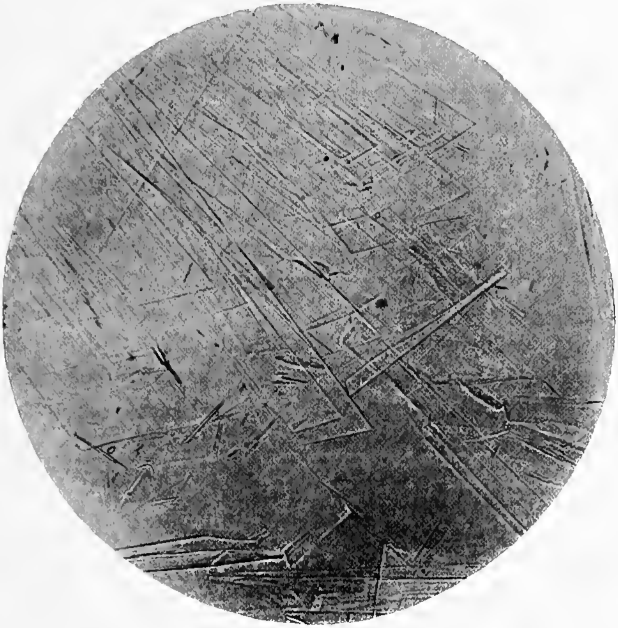


FIG. 8.—LARD CRYSTALS. × 140.—(*Bureau of Chemistry.*)

FIG. 9.—BEEF FAT CRYSTALS. × 140.—(*Bureau of Chemistry.*)

expert with the microscope may not be able without some difficulty to detect these adulterations by the simple tests above mentioned.

Commercial Classification of Lards.—In addition to the kinds of lard mentioned above other varieties are known in commerce.

Neutral Lard.—This, which is one of the best varieties of lard, is made from the fat derived from the leaf lard of the slaughtered animal in a perfectly fresh state, that is, taken immediately after slaughter and before the carcass is cold. The leaf lard, when it is removed from the animal, is at once placed in cold storage or put into cold water, in order to rapidly remove the animal heat. As soon as it is thoroughly chilled it is reduced to a pulp in a grinder and sent at once to the rendering kettle. The fat is rendered at a very low temperature, from 105 to 120 degrees F. (40–50 degrees C.). It is evident that only a part of the lard is separated at this temperature, and this part is regarded as being of the best quality, almost tasteless, free of acids and other impurities. The residue from the making of neutral lard is sent to other kettles, where it is subjected to a higher temperature and the remainder of the lard extracted, which is sold under the name of another grade. Neutral lard, obtained as above, while still liquid, is washed with water containing a trace of sodium carbonate, common salt, or a dilute acid. The product thus formed is almost neutral in its reaction to litmus paper containing not to exceed .25 percent of free acid, but it has more water and mineral matter than is found in the pure rendered untreated lard. The neutral lard made in this way is not used so commonly for culinary purposes but chiefly in the manufacture of oleomargarine.

Leaf Lard.—The residue of lard obtained by rendering the unseparated part of lard from the above process at a higher temperature is also of a high quality and is sometimes improperly designated leaf lard, a term which should be reserved for the whole product instead of a part obtained by rendering the residual leaf fat.

Choice Kettle-rendered Lard.—The amount of neutral lard which is demanded in the manufacture of oleomargarine does not by any means exhaust the supply of leaf lard. For making choice kettle-rendered lard the leaf lard together with the fat cut from the back of the animal is rendered in steam-jacketed open kettles and produces a lard of a high quality known as kettle-rendered or choice kettle-rendered lard. The hide is removed from the fat portion of the back used for this purpose before the rendering. Both the leaf and pieces of the back are passed through a fine sausage grinder before they enter the rendering kettle. According to the requirements of the Chicago Board of Trade, choice lard, which is another term for the above variety, is to be made from leaf and trimmings only, either steam-rendered or kettle-rendered, and the manner of rendering to be branded on each package.

Prime Steam Lard.—The prime steam lard of commerce is made as follows: The whole head of the hog, after the removal of the jowl, is used for rendering. The heads are placed in the bottom of the rendering tank. The mesenteric fat adhering to the small intestines is also used in the tank. Any fat that may be attached to the heart or other organs of the animal may also be used. In those factories where kettle-rendered lard is not made the scrap fat from the back of the animals and trimmings are also used. When there is an excess of leaf it is also put in the rendering tank and, in general, all the fat portions of the body which are removed in the trimming process. It is thus seen that prime steam lard is a term which may practically represent the average fat of the whole animal.

Prime steam lard is thus defined by the Chicago Board of Trade: "Standard prime steam lard shall be solely the product of the trimmings and other fat parts of hogs, rendered in tanks by the direct application of steam, and without subsequent change in grain or character by the use of agitators or other machinery except as such change may unavoidably come from transportation. It shall have proper color, flavor, and soundness for keeping, and no material which has been salted shall be included. The name and location of the renderer and the grade of the lard shall be plainly branded on each package at the time of packing." All the lard which is made is subjected to the approval of inspectors both as to the material employed and the method of procedure, together with the character of the final product.

Disposition of the Intestines of the Hog.—In the term intestines is included all of the abdominal viscera of the animal but not the thoracic viscera, namely, the heart and lungs. The material is handled in the following way: When the animal is opened the viscera are separated, including the flesh surrounding the anus and a strip containing the external genito-urinary organs. The heart is thrown to one side and the fatty portions trimmed off for lard. The rest of the heart is used for sausage or for fertilizer. The lungs and liver are either used in the manufacture of sausage or for fertilizer. The rectum and large intestines are separated from the intestinal fat and peritoneum and, along with the adhering flesh and genito-urinary organs, sent to the trimmer. All flesh from the above-mentioned organs is cut away and the intestine proper is used for sausage casings. The trimmings, including the genito-urinary organs, are washed and placed in the rendering tank where lard is made. The small intestine is also separated from the fatty membrane surrounding it and prepared for sausage casings. The remaining material, consisting of the peritoneum, diaphragm, stomach, and adhering membranes, together with the intestinal fat, constitutes the "guts" which are subjected to washing in three or four different tanks. In the first tank the stomach and peritoneum are split open, and also any portion of the intestines which still adhere to the peritoneum. The portions then go from tank to tank, usually four in number, and are then ready for the rendering tank.

The omentum fat is cut from the kidneys, and the kidneys with any adhering fat go into the rendering vat. The spleen, pancreas, vocal cords, trachea, and œsophagus also go into the tank.

In general it may be said that everything connected with the viscera go into the rendering tank with the following exceptions: First, that portion of the intestines which is saved for sausage casings; second, the liver and lungs; third, that part of the heart free from fat.

In the killing of small hogs, where the intestines are not of sufficient size to be suitable for sausage casings, they also go into the rendering tank. It should be stated here that the grease or lard obtained by the rendering of the above described viscera, according to the statements of the manufacturers, is used solely in the manufacture of lard oil and soap, and does not enter into the lard of commerce.

When the processes of manufacture are properly controlled by official inspection the public may be assured that this disposition of the fat obtained by the rendering of the intestinal viscera is secured.

Butchers' Lard.—A considerable quantity of lard is made for commercial purposes by the small butcher for family use, etc. This lard is made almost exclusively by rendering in the open kettle. In the country where butchering is conducted for family use the ordinary open kettle is placed over an open fire. All parts of the fat of the animal which can be easily separated and the scraps derived from trimming the animal are used for rendering. The offal and refuse of the animal are also rendered separately and the product used for soap grease. The lard made in this way is regarded as perfectly wholesome, but it is frequently dark-colored from the charring due to rendering over the open fire and by reason of using some portions of the animal, such as tendons, from which glue is made. Such lard may contain traces or even considerable quantities of glue which, however, cannot be regarded as an unwholesome product. The partially browned residues in the kettle in the country are known as "cracklings" and are used for soap grease.

Inedible Hog Fat Products.—In the shipping of hogs a great many are smothered and others die of disease or are in a condition, at the time of slaughter, which renders them unfit for human food, either by the presence of disease or otherwise. The fats are separated from dead animals of this class and are used for technical purposes such as burning oils, soap grease, etc. There are several varieties of these inedible fats of which the following are the principal:

White Grease.—This grease is made chiefly from hogs which die in transit by being smothered or from freezing. Formerly it was the custom to make white grease also from the animals which died of disease, but the manufacture of this product has been restricted by certain state laws which forbid the use of animals which die of particular diseases, such as hog cholera, from being used for any purpose whatever and their carcasses are to be buried so as to remove all danger of infection.

Brown Grease.—Brown grease is a product of a lower grade than white grease and is made usually by rendering the whole animal. It is one of the by-products in the manufacture of tankage from condemned animal carcasses, the tankage being used as fertilizer. Both white and brown grease are used chiefly in the manufacture of low grade lard oil and in the making of soap.

Yellow Grease.—Yellow grease is a product intermediate in value between white and brown grease. It is made chiefly from the carcasses of animals that die while on the packers' hands. It is used for the same purpose as white and brown grease.

Pig's-foot Grease.—A special variety of grease is made from pigs' feet as a by-product in the glue factory. This grease is used also in making lard oil and soap. It is evident that these varieties of grease are only inedible varieties of lard, and through proper inspection the public is protected against the use of these varieties of grease in the edible product.

Lard Stearin.—Mention has already been made of the fact that by melting a fat and cooling it slowly towards its solidifying point, certain constituents of the fat which have a higher melting point separate first, leaving those constituents with a lower melting point still in a liquid condition. Those portions of an oil or fat which separate first under such conditions, are the constituents of the product which is known as stearin, while the part that remains liquid is the constituent known as olein. Lard stearin is made principally for the manufacture of mixtures and is a by-product of the highest grade of lard oil. Lard stearin is made as follows: The lard is melted and kept in a crystallizing room at from 50 to 60 degrees F., until it is filled with the crystals of the separated stearin. The product is then wrapped in cloth in the form of cakes. Each package contains from 10 to 20 pounds. The cakes are then placed in a large press with suitable arrangements to facilitate the escape of the oil and maintain the low temperature. The pressure is applied very gradually at first, and as the process advances, with increasing power. The high grade oil obtained in this way is known as prime or extra lard oil and is used for illuminating and lubricating purposes. The resulting solid product, which is principally stearin, is used as one of the adulterants of lard, that is, in making a mixture which is sometimes called lard, composed of lard stearin and cottonseed oil.

Tanks Used for Producing Lard Under Pressure.—There are various forms of tanks used for producing steam rendered lard. In the open kettle there is a jacketed arrangement by means of which steam, at the proper temperature, is made to act upon the contents of the inner kettle. In the closed kettle the steam may be applied in the form of a jacketed arrangement or introduced directly into the kettle. The residues which remain after the steaming is completed and after the lard has been drawn off are withdrawn

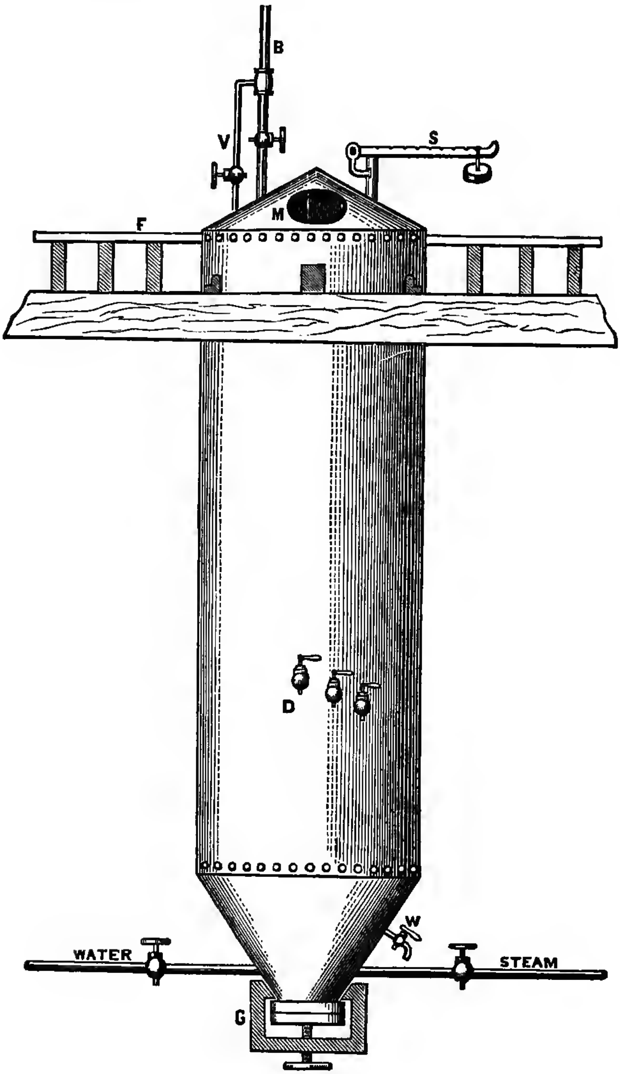


Fig. 10.

from the conical lower portion of the kettle which can be opened for the removal of these residues. A typical kettle for rendering lard is shown in Fig. 10. The fragments of meat to be received are placed in the opening M which is then properly closed when the tank is full. Steam is admitted and the condensation which is produced at first by the cold contents of the tank is drawn off through a water pipe. After the tank is thoroughly heated and the fat begins to separate the lard will rise above the water and the solid fragments and at the end of the process will fill the upper part of the tank. By means of the cocks at D it can be determined to what depth the tank is filled with lard and the lard can be drawn off through these cocks until water begins to flow. The bottom of the tank at G is then opened and the residues withdrawn, dried and ground for tankage.

Physical Properties of Lard.—*Specific Gravity.*—The specific gravity of pure lard is to be determined at some definite temperature, inasmuch as a statement of its specific gravity without some reference to the temperature at which it is determined is likely to be misleading. It is not convenient to ascertain the specific gravity of a lard at a temperature below its melting point. It is customary, therefore, either to take the specific gravity at about 40 degrees C., or at the temperature of boiling water.

The average specific gravity of pure lard at 40 degrees C. (104 degrees F.), regarding water as 100, is 89, and at 100 degrees C. it is 86, the weight of water being determined at the point of greatest density, namely, 4 degrees C. (39 degrees F.). Unfortunately the specific gravity of pure lard is not very greatly different from that of other oils or other fats used in its adulteration. For this reason it is not of the highest value for determining whether or not the pure article has been subjected to adulteration.

Melting Point.—The melting point of a pure lard is a physical characteristic of great value, since it is chiefly influenced by the part of the body of the animal from which it is made. The fat which is rendered from the foot of the hog has the lowest melting point, namely, about 35 degrees C. (95° F.). The fat adhering to the intestines has the highest melting point, namely, 44 degrees C. (111 degrees F.). The fat derived from the head of the hog has a slightly higher melting point than that from the feet. The kidney fat has a melting point of 42.5 degrees C. (108.2 degrees F.). In the steam rendered lards, representing the average of lards passed upon by the Chicago Board of Trade, the average melting point is found to be about 37 degrees C. (98.7 degrees F.). The melting point of superior or leaf lard has an average value of about 40 degrees C. (104 degrees F.).

Color Reaction.—A pure high grade lard when mixed on a white porcelain plate with the proper amount of sulfuric or nitric acid should give only a very slight coloration. The production of any considerable quantity of color, either brown or black, indicates the presence of organic impurities in the lard.

Rise of Temperature with Sulfuric Acid.—The various fats give different degrees of heat when mixed, under certain conditions, with strong sulfuric acid. It is possible to determine the approximate degree of the adulteration of lard by applying this test. The operation is a simple one and is conducted in the apparatus shown in Fig. 11. A common test tube about 24 centimeters in length and 5 centimeters in diameter is hung as indicated in the figure, and provided with a stopper carrying a thermometer in the center with a bent glass rod stirrer passed loosely through the stopper on the side and a funnel for the introduction of the acid on another side of the thermometer. A coil which is on the stirring rod is so arranged as to permit the bulb of the thermometer to pass through its center.

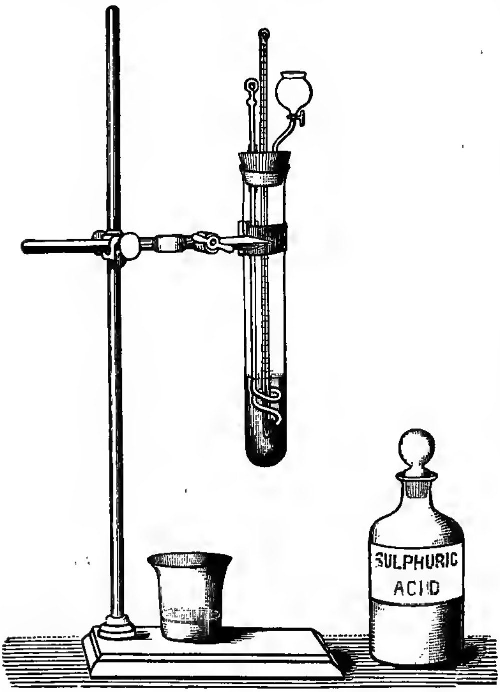


FIG. 11.

Manipulation.—Fifty cubic centimeters of the fat or oil to be examined are placed in the test tube and warmed or cooled, as the case may be, until the temperature is the one required for the beginning of the experiment, say 35 degrees C.; 10 cubic centimeters of the strongest sulfuric acid at the same temperature are placed in the funnel, the stopper being firmly fixed in its place; the test tube containing the oil is placed in a non-conducting receptacle; the wooden cylinder lined with cork, used in sending glass bottles by mail, is found to be convenient for this purpose. The glass rod or stirrer which fits loosely in the stopper, so as to be moved rapidly up and down, is held by the right hand of the operator; with his left hand he opens the glass stop-cock of the funnel and allows the sulfuric acid to flow in upon the oil. The glass stirring rod is now moved rapidly up and down, for about 20 seconds, thus securing a thorough mixture of the oil and acid. The mercury rises rapidly in the thermometer and after two or three minutes reaches a maximum, and then, after two or three minutes more, begins to descend. The reading is made at the maximum point reached by the mercury. With pure cottonseed oil, linseed oil and some other substances the rise of temperature is so great as to produce ebullition in the mass, causing it to foam up and fill the tube. To avoid this, smaller quantities of acid should be used or the oil in question be diluted with a less thermogenic one, so that the maximum temperature may not be high enough to produce the effect cited.

Chemical Properties.—*Volatile Acids.*—The quantity of volatile acid arising on the decomposition of a soap made by the saponification of lard is very minute in lard of high quality. The total amount of volatile acid should not be in excess of that necessary to saturate .2 cubic centimeter of deci-normal alkali solution.

Fixed Acid.—The quantity of fixed acid, consisting principally of oleic and stearic, in pure lard should not be less than 93 percent. The total quantity of free acid in lard, that is, acid uncombined with the glycerine, should not exceed one-half of one percent, and in neutral lard should be much less than this.

Quantity of Iodin Absorbed.—All common fats and oils have the property of absorbing, under given conditions, certain quantities of iodin. Lard of the highest quality should not absorb more than 60 percent of its weight of iodin. The lard made from the feet and certain other parts of the animal, however, may have a larger iodin number, rising as high as 75 or even 80.

Properties of Lard.—The average properties of different classes of lard in relation to physical and optical conditions are shown in the following table:

Specific Gravity. 35° C.	Melting Point. ° C.	Refractive Index. 25° C.	Rise of Temperature with Sulfuric Acid. ° C.	Water. Percent.	Iodin Absorbed. Percent.
.9053	40.7	1.4620	41.5	.077	62.48

The above table is the average composition of nineteen samples of lard furnished under affidavits of purity and which appear from their chemical and physical properties to be composed purely of the fat of swine taken from those parts of the animal usually devoted to lard making. The average data may be regarded as representing the properties of the ordinary pure commercial lard on the market.

Average Properties of Steam Lard.—Below is given the average composition of eleven samples of steam lard furnished under affidavit and, apparently, as judged by their chemical and physical properties, composed solely of the fat of swine. Steam lards are not of as high a quality as the lards contained in the preceding table. They have usually a distinctively strong odor, quite different from that of lards which are rendered in open kettles at low temperature and from selected portions of fat.

Specific Gravity. 35° C.	Melting Point. ° C.	Refractive Index. 25° C.	Rise of Temperature with Sulfuric Acid. ° C.	Water. Percent.	Iodin Absorbed. Percent.
.9055	37.0	1.4623	39.9	.109	62.86

Properties of Adulterated Lards.—It is possible to mix together the different materials used in making adulterated lard in such a manner as to produce a compound which in some respects resembles the natural product. This compound, however, necessarily differs from the natural product in its physical and microscopic properties and in its reaction with various chemicals which give distinct color with the different fats and oils used as adulterants. The mean properties of thirteen samples of mixed or compound lards are shown in the following table:

Specific Gravity. 35° C.	Melting Point. ° C.	Refractive Index. 25° C.	Rise of Temperature with Sulfuric Acid. ° C.	Water. Percent.	Iodin. Percent.
.9060	40.6	1.4634	46.5	.098	63.58

These lards, in addition to the above properties, show distinct color reaction with sulfuric and nitric acid and with the reagents which are distinctive of cottonseed oil. They are mostly mixtures of lard and tallow stearin with cotton oil or cotton oil stearin.

In addition to the adulterations already mentioned, as mixing with cottonseed oil, may be added the use of cocoanut oil. It is not probable that in the United States any adulteration of lard with coconut oil has been made for commercial purposes. Such an adulteration, however, is practiced in some foreign countries. Coconut oil contains considerable quantities of volatile acid, and, therefore, when used as an adulterant of lard, would increase the normal quantity of volatile acid materially. One sample examined by Allen, of England, was found to contain a quantity of coconut oil, amounting to 33 percent.

Summary.—In the preceding pages has been given a description of the character of lard, the sources from which it is made, the method of its preparation, its chemical and physical properties and the common adulterations to which it is subjected. There is no question of the wholesomeness of the usual fats and oils, or parts thereof, which are used in the sophistication of lards. The adulteration is intended solely for fraudulent purposes, that is, to sell under the name of a higher priced article one of a lower price.

There are many persons who prefer to use vegetable oils and fats as substitutes for lard in all cases. It is only fair to the consumer that the character of a fat and oil, however, for edible purposes be plainly made known to the purchaser. He is then to judge of the propriety or impropriety of using the articles in question. It seems quite certain that the use of vegetable oils and fats will be greatly increased in this country. All hygienists grant that they are at least equally as wholesome as the animal fat and oil. They are certainly less open to suspicion as having been derived from diseased sources. As a rule, they are carefully expressed and properly refined, free from rancidity and from any mechanical or chemical constituents which render them unpalatable or unwholesome. They are generally much cheaper, perhaps the only exception being that of olive oil. These vegetable oils, as a rule are excellent for salad dressing, for frying and general cooking purposes and for the ordinary uses to which lard and other animal fats are devoted. A proper labeling of all such packages would increase the quantity consumed, restoring confidence to the public in the character of the goods purchased, and prove of mutual benefit to the grower, the manufacturer and the consumer. It must be remembered, however, that there are many people who prefer the animal fats, and so there will probably always be a large field for their use. Such consumers are entitled to secure the pure article, properly prepared from healthy animals and free from rancidity and organic impurities. Lard and other animal fats offered in this way will have a greater vogue, command a greater degree of confidence and secure a larger trade than if sold under conditions engendering suspicion and distrust.

SOUPS.

Classification of Soups.—The soups which are commonly consumed are divided into two great classes—those of animal and those of vegetable origin. Any liquid or semi-liquid preparation of a meat or vegetable or the two combined which may or may not carry particles of solid substances is classed with these preparations. Soups are generally used at the beginning of a meal, usually at dinner-time, and, as a rule, do not have any very high nutritive value. That they have a useful function cannot be denied, since the introduction of a small quantity of a condimental and slightly nutritive warm liquid into the stomach at the beginning of dinner tends to stimulate the secretive glands of the stomach walls to greater activity and thus to promote digestion. Soup should be regarded pre-eminently as a condimental and not as a nutritive substance.

Preparation of Stock.—In the making of stock the base of the material, as a rule, is that part of the meat and bone soluble in hot water. The best way of preparing this stock is as follows:

The meat and bones selected should be fresh, free from all impurities and be derived solely from healthy animals as soon as they have been slaughtered. Inasmuch as the shape of the material used is of little consequence the parts of the carcass that are cut away in the preparation of the usual cuts of the marketable meats are utilized for stock making. The flesh should be cut into fragments of proper size and the bones broken up into small pieces. This material with the appropriate amount of water and salt is placed in a vessel capable of being closed in such a way that no aqueous vapor will escape, and a slight degree of pressure, equal to the half of an atmosphere, can be sustained. Simple forms of digesters are made for this purpose which are perfectly safe at low pressure and supplied with a safety valve so as to allow steam to escape if the pressure runs too high. Several hours of digestion are necessary for the preparation of stock, and if an ordinary vessel is used care must be exercised that the liquid does not evaporate so as to make the mass dry. Stirring from time to time assists the solution of the soluble substances. After the extraction is complete the liquid contents are poured off and the solid material pressed gently to separate the liquid held in solution. The mass is then put in a cool place and allowed to stand until thoroughly cooled and all the fat particles are collected at the top. The fat is then removed and the resulting liquid strained to remove any solid particles. The clear solution thus obtained is set aside and used as stock in the preparation of the various forms of soups. When properly flavored and used by itself it produces the soup known as consommé.

The soup stock made in this way usually contains not less than 95 percent of water and not more than 5 percent of nutritive matter. Many of the clear soups prepared in this way contain very much less nutritive matter, sometimes as low as one percent. It is evident, therefore, that the soup stock is valuable as a condiment and flavoring and not as a food.

The number of soups which can be made from soup stock is practically unlimited. They are formed by the admixture, chiefly of vegetables cut into small pieces, of starchy materials, mashed peas or beans, particles of potato, fragments of parched bread, and in fact almost any nutritive and palatable substance which the cook may wish to employ.

A soup made from a stock of the above description with pea flour was found to have the following composition:

Water,	88.26	percent
Protein,	3.38	"
Fat,	.93	"
Ash,	1.13	"
Starch and other carbohydrates,	6.30	"

A soup made with potatoes from stock of the above description was found to have the following composition:

Water,	90.96	percent
Protein,	1.37	"
Fat,	1.53	"
Ash,	.99	"
Starch and other carbohydrates,	5.13	"

The French make soups which are very well known and highly valued by cutting vegetables, such as carrots, beets, radishes and other vegetable substances, into small pieces and adding them to the soup stock.

Oyster Soup.—A soup made of milk, cream, flour, condiments, oysters and the liquid of oysters is very largely eaten in the United States. The difference between oyster soup and oyster stew is chiefly in the amount of oysters employed.

Green Turtle Soup.—A soup stock prepared as above described and flavored with pieces of green turtle is a very common dish.

Mock Turtle Soup.—A soup made in imitation of a turtle soup in which veal takes the place of turtle for flavoring is known as mock turtle soup.

Clam Soup or Clam Chowder.—This is a soup made of clams in the same way that oyster soup is made. When the clams are cut into small pieces and are in great abundance and when potatoes are used in large quantities in the mixture it is known as clam chowder.

Beef Extract.—It is evident that a beef extract is only a soup or a soup stock specially prepared from beef. Beef extract first became known by the researches of the celebrated chemist Liebig, and has passed from a mere local preparation to an article which is important in commerce. Factories have been established in localities far removed from the principal markets of the world, but where cattle are extremely plentiful, as in South America, and the preparation of beef extract is carried on on a large scale, the meat of the animal being thrown away after the preparation of the extract. The method of preparing beef extract is practically that described for making a soup stock under pressure. Instead of using only the trimmings and refuse of the animal, however, usually the whole of the flesh is employed. The bones are sometimes used in the making of a beef extract. The sound, fresh meat is cut into small pieces and extracted under pressure as already described. After cooking and filtering the product it is brought, in vacuo, to a proper consistence. Meat extract is, therefore, simply a concentrated soup stock. It requires about thirty-four pounds of meat to yield one pound of concentrated extract, and this extract may be diluted for consumption so as to make from six to seven gallons of beef tea. The composition of the ordinary beef extract of commerce shows that it contains from 15 to 20 percent of moisture, from 17 to 23 percent of ash and from 50 to 60 percent of meat bases, that is, the soluble nitrogenous contents of meat. The bones and tendons are not used in making beef extract on account of the introduction of considerable quantities of gelatine into the material. Liebig does not recommend the presence of gelatine in beef extract because, being cheaper in quality, it is an adulteration of the genuine article, which should contain only the pure bases and not the gelatinous principle of the meat in the tendons and bones.

Character of Nitrogenous Bodies in Beef Extract.—When beef extract is prepared according to the Liebig method those nitrogenous bodies commonly known as meat bases are found in the concentrated extract. In a beef extract which contains a total of 9.28 percent of nitrogen the quantity of nitrogen in the form of nitrogenous compounds which were found therein is as follows: Nitrogen in the form of soluble albumin,—trace; in the form of albumoses,—1.17; in the form of peptone,—trace; in the form of meat bases.—6.81; in the form of ammonia compounds,—.47; in the form of unenumerated compounds,—.83. The chief meat bases which form the principal part of the substance are creatin, creatinin, xanthin, carnin and carnic acid.

There are many different forms of beef extract upon the market, sometimes called by fanciful names and sometimes by the name of the manufacturer. Among the fanciful names are some which indicate origin or kind. The extracts which bear the names of the manufacturers are very numerous, but all of these extracts are essentially of the same character. One of these is a meat extract in which some of the meat fiber is contained. The quantity of meat fiber which is used varies, but is not very great. A comparison of the dry substance in a preparation of the class mentioned above with the dry substance in meat shows the following relation:

	Protein. Percent.	Meat Bases. Percent.	Ash and Mineral Matter. Percent.
Extract,	49.7	25.6	24.7
Meat,	86.7	7.8	5.3

The above data show that the extract is essentially different in its composition from dried meat and has added to it a large quantity of meat fiber or the meat rendered soluble by some kind of treatment.

Nutritive Properties.—It cannot be denied that meat extract, as has been said in the case of soup stock, contains only a small part of nutritive matter. This nutritive substance is in a state of solution and probably is more readily absorbed than a similar amount of other nutritives in the form of ordinary meat. Its chief value as a nutrient, therefore, is not in the amount of nutrient material which it contains, but in the ease and speed with which it may become absorbed into the circulation. In case of illness this is often a very important point. It is not a question so much of the utilization of a large amount of nutrients as the absorption and assimilation in small quantities which will sustain life until the disordered conditions disappear. For these reasons the meat extracts have a value. There is, however, little doubt of the fact that in the popular mind a great deal more credit is given to meat extracts than should properly belong to them. They must be regarded principally as condimental and incident to nutrition rather than as nutritive substances. The claims which are made by the manufacturers are sometimes misleading, as, for instance, that one pound of extract contains the nutritive properties of many pounds of meat. Such a statement, of course, is absurd upon its face and should not be allowed to go unchallenged. Even when meat extracts are reinforced by the addition of soluble or comminuted fiber, as is often the case, the quantity of nourishment is very small as compared with a similar weight of meat itself.

It is not intended by the above remarks to cast any discredit upon the value of beef extract, as its value has been attested in numerous cases. It is only designed to call attention to the fact that as food these extracts have comparatively little value. They may be useful as stimulants or as condimental substances or as a means of speedily introducing a soluble nutrient in the case of disease where it is extremely important that even small amounts of nutritious material should enter the body.

Beef Juice.—A distinction is made between a beef extract and a beef juice. The latter term applies solely to the liquid naturally remaining in the fresh meat after its proper preparation for consumption, that is, after the withdrawal of the blood and the proper cooling and storing of the flesh. The fresh meat is then subjected to strong pressure and the juices which are extracted are concentrated in vacuo to the proper consistence. The meat of old bulls is often used. A true beef juice must be extracted from the cold meat and not with the aid of heat, hot water or other solvents. It is difficult to preserve an extract of this kind without sterilization, and the heat required for sterilization is likely to coagulate some of the albuminous material which is expressed. It is a great temptation, therefore, in some cases to preserve the beef juice by a chemical preservative other than common salt. Boric acid and sulfite of soda may be used for this purpose, but these substances are objectionable on the score of possible injury to health. Glycerine is also used. Inasmuch as these juices are usually given to invalids or those whose digestive functions are impaired it is most important that injurious substances should be omitted. In case of pressure it is advisable, in some cases, to chop the meat very fine, and in this comminuted condition extract the juice with cold water. This does not produce any change in the character of the juice and the water is subsequently removed by evaporation at a low temperature in vacuo. Beef juices are usually prepared from heated meats.

Composition of Beef Juice.—The composition of beef juice from different parts of meat which was previously heated externally is shown in the following table.

COMPOSITION OF BEEF JUICE AND MEAT EXTRACT.

	Beef Juice.	Meat Extract.
Water,	90.65	21.66
Ash,	1.36	20.46
NaCl (salt),	.15	5.47
P_2O_5 (phosphoric acid),	.36	4.55
Fat,	.19	.50
Acid (as lactic),	.15	8.42
Nitrogen (total),	1.15	7.66
" insoluble and coaguable,	.68	.48
" as proteoses,	.04	2.02
" as peptones,	.14	1.90
" meat bases,	.30	3.05
" creatin,		.75
" xanthin bases,		.04
" ammonia,		.21

The above analyses show the general character of meat juice extracted first by externally heating the meat and then pressing. They show that there is less nitrogenous material present in meat juice than there is in meat extracts. It is evident that meat juices cannot be heated for sterilization without coagulation of the albumins. When it is advisable to use a beef juice in a case of illness it is far better to prepare it at the time when it is used than to prepare it on a commercial scale and preserve it by any of the chemical means in vogue. Meat juice can be very well prepared for domestic use by chopping the meat very fine, placing it in a vessel, heating to 140° F., and pressing it by any simple means, as, for instance, with the hand or by using an ordinary lemon squeezer. The juice obtained in this way can be flavored with salt and spices to suit the taste of the patient, and used immediately. In some cases, in order to get a greater yield, pure cold water may be mixed with the chopped meat and a somewhat dilute juice obtained but giving a greater yield of nutritive material for the same weight of meat.

Various names, fanciful and otherwise, are given to the so-called beef juices. These names are either fanciful or, as in the case of beef extracts, that of the manufacturer. Some of the fanciful names are, like those already mentioned, suggestive of origin. Some of these have large quantities of coagulable protein, like albumin, while others have such small quantities as to indicate that they are not wholly beef juice. In the case of some of these preparations there is some indication that they are prepared chiefly from blood and thus are not true meat juices. Naturally there must be particles of blood in a meat juice and the mere occurrence of blood cells would not be an indication that blood itself had been used in its preparation. By reason of these facts the use of so-called meat juices is restricted. They contain relatively very little nutritive material, they are sometimes preserved with harmful chemicals and they may be made from blood, and in general there is such a degree of secrecy attending their preparation as to warrant the physician and patient to confine themselves to the domestic article prepared at the time of using. Another objection which is not of a hygienic character is found in the great expense of securing a very little nourishment by this means. The quantity of juice which meat will yield is very small and, therefore, the relative expense for any given quantity of nourishment is far greater than it is even in the case of beef extract. While in the case of rich patients an objection like this is of little value, in the great majority of cases it should be given due consideration.

Soluble Meats.—Various attempts have been made to put soluble meats upon the market for use, especially for invalids and in cases of disordered digestion. The principle which underlies the preparation of these meats is to subject them to a certain degree of artificial digestion, by means of which the protein matter becomes converted into soluble forms, either albumose, proteose or peptone. The process which is employed is a simple one, namely, the comminution of the meat into as fine particles as possible and its admixture with hydrochloric acid and pepsin. It is then subjected to artificial digestion until a considerable portion of the meat is soluble. Another method of preparation is to omit the pepsin and after the addition of hydrochloric acid to place the meat in a digestor where it is subjected to a temperature of steam under pressure for a considerable length of time. A goodly proportion of the meat becomes soluble under this process. After the preparation is completed the residual hydrochloric acid is neutralized by carbonate of soda, forming common salt, which gives the proper flavor to the compound.

The composition of soluble meat prepared in this way is given in the following table (Foods and Principles of Dietetics, by Robert Hutchinson):

Water,	67.21	percent
Fat,	5.93	"
Albumin,	11.00	"
Peptone,	6.51	"
Meat extract,	7.55	"
Ash and salt,	1.74	"

A meat solution of this kind is not really a solution, since not only is that part which passes into solution contained in it, but also the residual meat fibers which are not dissolved but so softened by the process that they lose their distinct form and can be rubbed up to a thick pasty mass. The product, therefore, consists not only of the part of the meat rendered thoroughly soluble in water by the process, but also of a residual part, softened and reduced to a paste. The mass has practically the same nutritive value as an equivalent amount of meat with the claimed advantage that a large portion of it is already soluble. This partial predigestion may be of value in cases of disease or disordered digestion of any kind, but there is no reason for believing that the healthy stomach requires any sort of artificial predigestion for the proper conduct of its functions. On the other hand, there is every reason for supposing that any kind of predigestion which is at all effective will in the end prove injurious to healthy digestive organs by depriving them of a part of their normal functions and thus tending to bring them to a condition of feebleness which may result in the omission, in part, of the normal functions of the vital organs.

Preparations of Blood.—There is no doubt of the valuable nutritive properties of blood and its preparations are sometimes used as foods. There is a deep-seated prejudice against the use of blood as human food, doubtless based on older and more effective grounds than even the laws of health promulgated by Moses. Man is an animal of some refinement of character and the sight or use of blood is repugnant to his finer instincts. Sometimes blood is dried and powdered and the blood powder mixed with other food.

Another method is to coagulate the blood, then remove the coagulated portion and use the residue for food purposes. This preparation, of course, contains no coagulable portions of blood, that is, the protein thereof known as fibrin. There is no reason for believing that preparations of blood will ever occupy any prominent position in the food supply, either of persons in health or of invalids.

Beef Tea.—A very common food preparation from beef is that known as beef tea. In all essential particulars beef tea is nothing more than a rich unfiltered soup stock. Inasmuch, however, as it is constantly prescribed in many kinds of illness and is prepared under certain conditions it should be mentioned specially here in addition to the preparations already described. As in the case of meat juice, beef tea should always be prepared in the home, and immediately before using. It is a preparation which can not be properly made and kept without the addition of some preservative which renders it totally unfit for human consumption. The very choicest portion of the beef should be selected in the preparation of beef tea and it should be reduced to a fine state of comminution. The removal of the fat and tendons should be as complete as possible, as particularly the latter tend to add to the extract more of the gelatine-like principles than is desirable. The fragments should be mixed with a sufficient quantity of cold water to make the desired amount of beef tea, usually one pound of water to a pound of comminuted beef is a good proportion. The mixture should be kept cold for a considerable length of time with frequent stirrings in order to extract as much as possible of the nitrogenous matter which becomes coagulated by heating. Salt may be used not only to promote the solubility but also to give the proper taste. After the lapse of an hour or more the vessel may be covered and gradually warmed. During this warming the mass should be frequently stirred so to as promote the solution. When finally the extraction is complete, before the tea is administered it should be cooked, that is, heated to the boiling-point, by which process the soluble protein is coagulated but not hardened, and the material is rendered more palatable. The beef tea should be administered without separating the coagulated fragments of albuminous material, which is in a state easily digestible, and adds much to the nutritive value of the mixture. Finally the residue of beef may be put into a bag and subjected to pressure to remove as much of the juice contained therein as possible. The difference between beef tea and soup stock, as will be seen, is largely in the filtering. The beef tea should retain the coagulated flocks, while in the soup stock they are removed. One pound of good lean beef and one pint of water yield about one-half pound of good beef tea. As in the case of soup stock, beef tea is not a very nutritive substance. It is, however, stimulating, and the nourishment which it contains is quickly absorbed. The soft, coagulated flocks of albumin are readily digested, and often a patient may be nourished for days on a preparation of this kind when he is in a condition which renders it impracticable to use either solid or other liquid foods.

Beef tea is also made on a large commercial scale and with some degree of approximation to the home prepared article. For various reasons, however, which have already been advanced, a well made domestic beef tea which can be used as soon as prepared is to be preferred in all cases to the manufactured article. A beef tea properly made has approximately the following composition:

Water,	88.00	percent
Meat bases,	3.50	"
Protein—soluble and flocculated,	8.00	"
Ash and salt,	1.50	"

Dried and Powdered Meats.—The preparation of dried meat has already been described. There has lately been placed upon the market a number of preparations dried and finely ground, under various names, fanciful and those of the manufacturer. Inasmuch as ordinary meats are largely composed of water, it is evident that if the water can be removed without impairing the quality of the meat, great expense in transportation would be saved and the use of preservatives would be unnecessary. Various attempts, therefore, have been made to place dried meats upon the market. The meat powders are not only offered in their natural state of desiccation but also are prepared with some degree of artificial digestion. One of the most common of these meat powders is known as *somatose*, which has been made in large quantities, and sold throughout all parts of the world. It consists largely of albumoses rather than of peptones, but this is true of a great many of the so-called peptone preparations. The composition of somatose is represented in the following table (Allen's Commercial Organic Analyses, Vol. IV, page 384):

Water,	14.25	percent
Albumin rendered soluble by alkali,	21.83	"
Albumin,	3.40	"
Albumoses,	33.96	"
Peptone,	3.06	"
Meat bases,	2.62	"
Ash and salt,	5.30	"

The above data show that the meat still contains nearly 15 percent of moisture and that an alkali has been used to render the protein more soluble. This alkali has increased the quantity of mineral matter over that which would naturally be present. Whatever may be the relative value of the prepared protein matter as compared with that in the original meat, it is seen that a large quantity of it, practically as much as was in the original meat, has been preserved in the finished product. Whether or not it is advisable to use a preparation of this kind is a question to be left with the physician. It may be said unhesitatingly that in all cases of health somatose could not possibly present any advantage over fresh meat. On the contrary, for theoretical and practical reasons, it is certain that it is less valuable.

Composition of the Ash of Meat Juice and Meat Broth.—The principal mineral component of the natural juice of meat broth or meat extract is phosphate of potassium, though there are also small quantities of magnesium and smaller quantities of calcium present. In addition to this there is a certain quantity of common salt present, which is determined, however, largely by the method of preparation. The following analysis shows the composition of the ash of a meat juice to which little or no common salt has been added:

Potassium (K),	34.40	percent
Sodium (Na),	9.70	"
Calcium (Ca),	.36	"
Magnesium (Mg),	2.55	"
Phosphoric acid (P_2O_5),	27.00	"

Other constituents are not determined in this analysis. The phosphate of potassium may therefore be regarded as the principal natural ash constituent of meat extract and meat juice. (Zeitschrift für Biologie, Vol. XII, 1876.)

Adulteration of Meat Extract.—The principal adulterations of meat extract have already been mentioned. The substances used in preserving it are of the greatest hygienic consequence. These are chiefly salt and glycerol or alcohol. The use of all of these substances is reprehensible. Fortunately they are seldom used. Another adulteration which has been practiced is mixing the meat extract with extracts of yeast. The extract of yeast has valuable dietetic properties and contains the active principles of fermentation. It also resembles, in many respects, physically and chemically, the extract of meat, and can, therefore, be mixed with meat extract, and, being a cheaper article, forms a mixture which can be sold at a greater profit. The presence of yeast extract in meat extract can easily be determined by treating the mixture with a strong solution of sulfate of zinc and filtering. In meat extract the filtrate obtained is always quite clear, but when a yeast extract is present the filtrate is turbid.

Active Principles Contained in Meat Extract.—Attention has already been called to some of the more important active principles, namely, meat bases which form a valuable portion of meat extract. There are various forms of nitrogenous bodies, however, besides meat bases, which become soluble naturally in meat or by the treatment of meat with digestive ferments. Lean meat, as is well known, consists almost exclusively of protein matter and water. This protein matter is principally insoluble. Under the action of digestive ferments the protein of meat becomes broken up into more soluble bodies, known as albumoses, proteoses and peptones,—the latter being the final product of solution. These bodies are still true protein bodies containing the element sulfur as one of their essential constituents. The meat bases, on the contrary, contain the other elements that are in protein but do not have the sulfur element. They belong to that class of bodies which is known as simple amido compounds. All of these bodies are mixed together in meat juice or beef extract, and it is an important task of the chemist to separate them, both that they may be identified and that their relative abundance may be closely determined. There is also another soluble or semisoluble protein substance in these extracts derived from the tendinous tissues and bones, namely, the gelatine or glue. This is quite a common product, being the soluble protein procured by the digestion of the tendons and bones. It is important, therefore, that the chemist should distinguish between the gelatine and the amido bodies. There is also a true and a false protein form of these soluble bodies, the true one being formed by natural proteolytic ferments and the false one being formed by heat or digestion under pressure of steam. The chemist should also be able to distinguish between the true extract formed directly from the meat and the yeast extract used as an adulteration.

It is not the purpose of this manual to enter into the details of how these different bodies may be distinguished from one another, as that is purely a chemical study. It is due, however, to the general reader that some explanation be given of the different classes of bodies which are contained in these extracts.

Relation between the Price of an Extract and its Nutritive Value.—The studies made in the Bureau of Chemistry show that there is little relation between the price of a beef extract and its real nutritive value. In three cases of extract which are all well known brands and are of the thick or pasty variety, showing that a dissolved meat had been added to them, the average weight of a package costing 45 cents was only 55 grams, or nearly a cent a gram. In another three samples of extract, also well known brands, of the same pasty variety and costing little more per package, it was found that the weight of the more expensive variety was double that of the first, costing only one-half cent per gram. In the case of the liquid extracts where no pasty material is incorporated there is still greater variation in the relation of the price to the nutritive constituents. An extract which retails for one dollar per bottle contains 91.69 percent of water and only .42 percent of nitrogen. Another so-called meat extract which retails at 60 cents per bottle must have been wholly an artificial product, since it contained no creatin or creatinin at all. It was also preserved by the addition of alcohol and contained an artificial coloring matter.

The ash existing in these extracts is, of course, usually due to the presence of large quantities of common salt. Sodium chlorid is added to this extract without any definite rule at all and sometimes in very excessive quantities. In some cases thirty percent of the total extract is composed of common salt. In other words, a person taking a solution of this kind would be injecting into his stomach a very concentrated brine. When common salt may be sold at the rate of one dollar per pound, the profit on the transaction is one which ought to make the business exceedingly attractive.

The total phosphoric acid in the ash also shows variations, and if it were not so easy to add artificial phosphoric acid the actual amount present might be taken as a base by which quality could be judged. In the natural extract the total phosphoric acid should be in the proportion to organic phosphoric acid as 10 to 1, which is the natural condition in which it is found in meat extract. In many cases the amount of inorganic phosphorus is so great as to render it certain that a phosphate, probably the phosphate of soda, has been added. In another case the quantity of organic phosphoric acid was very much greater than could have possibly been the case in a natural product, indicating the addition of lecithin or glycerophosphoric acid. The amount of fat in beef extract, when properly prepared, should be very small and should certainly not exceed one percent, since by the proper method of preparation the fat is largely separated. In the pasty material, however, where the meat is reduced to a pulp and retained in the package the amount of fat will be very much greater.

The Nitrogenous Bases.—The average nitrogen content of the pasty or solid extracts varies from 6 to 9 percent. The nitrogen in the meat juice is subject to much greater fluctuation, depending largely on the content of solids. Although a high nitrogen content is not a guarantee of the character or mode of manufacture of an extract, it is naturally expected and is desirable.

The addition of gelatine to extracts is now largely practiced and has been for some years. By adding gelatine the manufacturer raises or maintains a certain nitrogen content, but supplies the nitrogen in a form lacking in all quickly stimulating qualities, and the natural flavor of the meat extract nitrogen is lowered. The buyer is consequently deprived of the characteristic essentials of a beef extract although the nitrogen content is relatively high. In many cases only a small proportion of the original gelatine exists in the extract as such. The gelatine is converted by a gradual process of hydration into gelatoses and gelatine peptones. While the separation of gelatine from protein matter is a process in anything but a satisfactory condition, it is a far simpler process than the detection and separation of gelatoses and gelatine peptones from albuminoses and peptones. The question has not been thoroughly studied up to date.

The question of adulteration of meat extracts with gelatine is not the only form of adulteration we have to face. The mixing of varying amounts of yeast extract with meat extracts is being practiced at the present time in some countries. As we have not investigated this question, we cannot state whether it is practiced in this country at the present time or not.

Kinds of Preparations.—Meat preparations of the above types in general may be divided into three classes, liquid extracts, pasty extracts and powdered extracts. In addition to the above, within the last few years beef extract pellets, some of them being enclosed in gelatine capsules, have appeared upon the market. The old-time product of Liebig's extract belongs to the second class, in which we also find many of our best known brands. The liquid extracts are varied and numerous and their number is rapidly increasing. The amount of meat extractives in some of these liquid products is remarkably small, the quantity of solids in two or three cases being under 10 percent. Alcohol is sometimes met with in these liquid preparations. The meat powders are far less numerous than the extracts of the first two classes. They consist largely, if not entirely, of albuminoses and peptones in addition to some insoluble proteid matter.

Moreover, it is necessary to distinguish between a meat extract containing large amounts of stimulating amido-acids and relatively small percentages of albuminoses, peptones and insoluble proteid matter on the one hand, and, on the other hand, an extract, or, more properly, a meat product, which consists largely of albuminoses, peptones and insoluble matter and relatively small amounts of amido-acids. The food value of this last group of products is undoubtedly greater than that of the former group, but being sold as meat extracts, their value should be based on the amount of extractives they contain and not on their food value.

The value of the amido-bodies, such as the meat bases, as food, is of uncertain character, but we must admit, as in the case of alcohol, they can at least be burned and furnish energy to the body. Like alcohol, the value of meat extractives lies principally in their stimulating qualities. The active principles of tea and coffee are on a similar basis. As these simpler amido-bodies are the final links in the long chain of hydrolytic products of the proteid molecule prior to the complete resolution of that molecule into carbon dioxid, water, etc., it is readily seen that an ounce of meat extractives (the various amido-bodies) represents a far larger amount of beef than an ounce of albuminoses does. The various protein bodies and amido-acids are closely interwoven and it is impossible to produce amido-acids without producing albuminoses and peptones. Consequently, every commercial meat extract must consist partly of albuminoses, peptones, etc. The best of our extracts on the market to-day contain about 50 percent of their total nitrogen in the form of meat base nitrogen. When an extract contains less than 5 percent of its nitrogen in the form of meat base nitrogen the term "extract" seems to be no longer applicable. It is evident that the product represents much less meat than an extract with 50 percent of its nitrogen in the form of meat base nitrogen, provided the total nitrogen in both cases is approximately equal.

The proteid matter coagulated by heating to boiling, as well as the proteid matter insoluble in cold water, are both undesirable factors in an extract of meat. As a rule, the lower the proportion of these constituents, the higher the character of the meat extract. The same thing holds true in regard to the presence of albuminoses and peptones.

The quantity of total nitrogen in the form of meat base nitrogen in the best extracts reaches 50 percent. In one of the poorest it is 3.82 percent. The food value of the latter product might be greater than that of the former, but its cost of manufacture and its stimulating value are much less.

Creatin figures are very interesting and of much value in determining the source and value of an extract. Creatin is the principal amido-body found in meat, consequently we expect to find it or creatinin, its hydrated form, in still larger quantities in meat extracts. In several cases which came under our notice where the extract acted suspiciously, the creatin values were nil, and in such cases grave doubts exist as to the source of the extract. Our best extracts give high creatin as well as high meat base figures.

The xanthin bases and ammonia nitrogen figures present a variety of problems. While the xanthin bases are desirable constituents, ammonia in any amount is not. It is questionable whether the ammonia figures obtained by the magnesium oxid method do not give too high results (W. D. Bigelow).

Gelatine.—Gelatine is a substance obtained from the nitrogenous portions of bones, hide, horns, hoofs, connective tissue, tendons and other nitrogenous matter of the animal. One of the principal constituents of these bodies is a substance known as collagen. When this is heated either under pressure or without pressure it is changed to gelatine. Glue is unrefined gelatine or impure gelatine to which usually some substance has been added to increase its holding power. A type of gelatine known as isinglass is made from the bladders of sturgeons.

The general process of manufacturing gelatine is as follows (Whipple, Technology Quarterly, Vol. XV, No. 2, June, 1902):

"The hide scraps are first macerated and subjected to the action of a solution of lime or caustic soda in pits for two or three weeks. This dissolves most of the blood and saponifies the fats. The excess of lime or soda is then largely removed by washing and the solution steamed to dissolve the gelatine, but an excess of heat is avoided. Sulfurous acid is used to bleach the gelatine. When of sufficient strength, the gelatine is allowed to harden in molds or on slabs, and is ultimately dried in sheets on wire nets. Bone gelatine is made in a somewhat similar manner. The bones are crushed, boiled, treated with hydrochloric acid, and the gelatine is dissolved as before, washed, bleached and dried in sheets. The process requires a number of weeks."

Gelatine is also made from bones, fresh as well as old, and from the residues of bones used in the manufacture of buttons. The thin slices of the bones are treated with acid until all the phosphate of lime is extracted. They are then treated with lime and the gelatinous residue is then dissolved in warm water and purified for use.

The use of gelatine as a food has of late years become very common. The ease with which it can be made into jellies, the consistence which it gives to ice-cream and its general utility in the cuisine have made it deservedly popular. Gelatine is the product of some of the nitrogenous parts of the animal and should be made only from the edible parts thereof. It is particularly abundant in the tendinous portions of the animal and in the tissues about the head, from which a large part of edible gelatine is made. No portion of the animal which is filthy or unfit for food should ever enter into the composition of the gelatine. If the parts from which the gelatine are made are cured previous to manufacture they should be cured in a perfectly sanitary way, as carefully as any other part of the meat. There can be no objection to the use of gelatine made from these sanitary materials in foods of all kinds.

There is, however, a possibility that some of the gelatines on the market may be made from materials wholly unfit for food. The food law forbids the use of animal substances unfit for food either directly or indirectly. As an illustration of this condition of affairs I may call attention to the fact that a part of the gelatines sold in the United States are made from parts of animals slaughtered in South America. It is not known to the consumer in what conditions these parts are preserved and transported. They may be possibly packed with the hide and sent to Belgium or other countries in a filthy, putrid and abhorrent state and these parts be cut from the hides before they are sent to the tanneries and converted into gelatine and sold as edible gelatine. Such a possibility should not exist, and there is no danger of its existence with high class manufacturers. A part of the horns is also used for such purposes, which being of an inedible portion and unfit for food is not admissible, under the law, as a constituent of edible gelatine. All such materials should be excluded in the manufacture of such an important product. Further than this, it may be stated that the line of demarcation between gelatine and glue is not always as well drawn as it should be, and this is illustrated in the report that the gelatine and glue are manufactured in the same factory, and the same conditions of odor and insanitation which adhere to glue may attach themselves to the gelatine. Such a condition, of course, would be an exceptional case, but its possibility should be excluded. Under the food law only those forms of gelatine first described above can be legally made and sold for use in food.

Adulteration of Gelatine.—The adulterations of gelatine are such as those referred to above in the form of raw materials employed which are insanitary and unfit for food. In addition to this, bleaching agents, namely, sulfurous acid or sulfites and mineral acids, are often employed in the manufacture, portions of which may remain in the finished article. All of these substances must be regarded as adulterants and as insanitary and unsuitable for gelatine, and to that extent unfit for human consumption.

Presence of Tetanus in Commercial Gelatine.—The Public Health and Marine Hospital Service has investigated gelatine to determine whether or not it may be infected with pathogenic germs. The conclusions of the investigation are as follows (Bulletin No. 9, Hygienic Laboratory):

"Seven samples of gelatine examined; one showed tetanus spores.

"Two samples showed an oval end-spore rod, whose identity was not proved, but, in stained specimens, it would be hard to distinguish from tetanus, if indeed not tetanus with diminished virulence.

"In tetanus investigations it is important to use *freshly* made bouillon, as the organism is apt not to germinate in bouillon over ten days old. The thermal death point of the organism isolated was found to be between twenty and thirty seconds at 100 degrees C.

"It is important, therefore, that gelatine to be used for injections should be boiled at least ten minutes on account of the variability of the thermal death point in different species of tetanus. Whether this amount of heating impairs in any way the hemostatic power of gelatine has not been settled, but in case it does it is believed that the danger from tetanus more than overbalances its therapeutic value.

"It is suggested that when, as in hospitals, there is likelihood of gelatine injections being used for hemostatic purposes the gelatine solution be sterilized by the fractional method on three successive days and kept ready for use in sterile containers."

From the data given above it is seen that gelatine may become infected and the material from which it is made for edible purposes should be healthful, sanitary and fit for food. It is not likely that tetanus germs would prove dangerous when taken into the stomach, but freedom from infection should be secured if possible. These investigations show the wisdom of the pure food law in forbidding the use of parts of animals unfit for food, whether manufactured or not, in the production of food products. It is evident that a sufficient quantity of fresh, sanitary material or material properly preserved can be obtained in this country or in other countries to supply the needs for edible gelatine without resorting to the use of inedible parts of hides, horns, hoofs and other waste and unfit portions of the animal.

Summary.—Above have been presented some of the principal meat foods, the analytical data which show their composition, the processes by means of which they are prepared and the principal methods, objectionable and otherwise, by which they are preserved.

Meat is a staple article of diet among almost all nations of men. The anatomical structure of the human animal indicates that his environment has adapted him to eating meats of all kinds. In other words, man is an omnivorous animal. He has been developed in an environment in which all kinds of meats and vegetables have ministered to his sustenance, and thus he is an omnivorous animal both by evolution and necessarily by heredity. That man can live and flourish without meat has been fully established by experiments, but that man cannot be nourished by meat alone has likewise been fully established, so that if the human race were necessarily to be deprived either of animal or vegetable foods, it would be the animal food which must be sacrificed.

It is not the purpose of this manual to discuss the relative merits of vegetarianism as compared with the common diet of the human race. It may not be amiss, however, to say that probably in the United States especially, a larger quantity of meat is eaten than is either necessary or wholesome. The people of our country are better able to supply themselves with expensive foods than those of other countries, and of the common foods meats are far more expensive than cereals. The eating of larger quantities of cereals and smaller quantities of meat would probably be conducive both to economy and health. It appears to be certain that the meat eating of the future may not be regarded so much as a necessity as it has in the past, but that meats will be used more as condimental substances than as staple foods. In all meat, for instance, that costs 25 cents a pound, such as steaks, there is over one-third or a half of it which is inedible, so that the edible portion really costs double that amount. On the contrary, when a pound of flour or maize is purchased, the price of which is perhaps only one-eighth that of meat, the whole of it is edible. Thus, from the mere point of economy as well as of nutrition the superiority of cereals and other vegetable products is at once evident. On the one hand, a cereal is almost a complete food containing all the elements necessary to nutrition, and it costs only a few cents a pound. On the other hand, a steak or roast is only a partial food and it costs much more than cereals.

It is hoped that one purpose of this manual may be secured, namely, by showing the consumer the actual composition of the different kinds of food and their method of preparation he may be led in the selection of his food to follow the dictates of science and economy to a certain extent rather than merely the impulse of taste. The eating of such large quantities of meat is merely a habit which often is developed in children through the carelessness and ignorance of parents, much to the detriment of the child as well as to his future health and activity. It is believed that if the true principles of the use of meat were properly inculcated a large saving in the energy of the wage earner as well as of those in more affluent circumstances would be secured.

Sound principles of economy establish a better condition of health and lead to greater activity and fruitful labor.

Terrestrial Animal Oils.

Terrestrial animal oils are obtained directly from parts of the animals which yield, at ordinary temperature, a substance which remains liquid. The fats which are in the feet of the animals are usually more liquid than [illegible] of the body and hence the natural animal oils are derived largely from the feet. Among the most important are sheep's foot oil, horse foot oil, and neat's foot oil, which is obtained from the feet of cattle. These oils are all highly valued for technical purposes, especially for lubricating, and for this purpose bring a very high price. They are not used or should not be used for edible purposes, though they perhaps may sometimes be used in cooking. Neat's foot oil, especially, on account of its high price, is often subjected to adulteration, and is mixed for this purpose with cheap vegetable oils, such as cottonseed. Fish oil is also often used in the adulteration of neat's foot oil, though the addition of any of these oils to neat's foot oil raises the iodin number to a very high degree, and hence this addition is easily detected by the chemist.

Lard Oil.—Lard oil is one of the most important of terrestrial animal oils. It is made from lard by melting it and allowing it to slowly cool. The stearin in the product crystallizes first, and when it reaches a condition favoring the separation of the stearin the mass is subjected to straining or pressure, whereby the olein or liquid portion of the oil is separated, and thus, having been freed from the most of its stearin, remains liquid at ordinary temperature. The residue is known as lard stearin and is largely employed in the preparation of lard to give it a higher melting point and in the manufacture of oleomargarine.

Lard oil is used to some extent for edible purposes and is itself sometimes employed in the manufacture of oleomargarine when mixed with tallow or tallow stearin.

Properties of Lard Oil.—It is evident that the chemical and physical properties of lard oil are determined by the completeness with which the stearin is separated. Inasmuch, however, as the conditions of manufacture are nearly constant, lard oil has characteristics of a physical and chemical nature which do not vary greatly. The specific gravity of lard oil at 15 degrees is about .916, and its iodin number varies from 68 to 75. When made of the best material it has a neutral taste, not an unpleasant odor, and, therefore, can be used for edible purposes without introducing any characteristic odor or flavor into the prepared food. In point of fact, however, it is not used to any extent for edible purposes except in the manufactured articles above mentioned. When carefully made and of the proper quality pure lard oil should be practically free from free acid.

Adulterations.—On account of the high value of lard oil for lubricating and other purposes it has been subjected to extensive adulterations. The addition of cheaper animal oils or vegetable oils has been largely practiced. Fish oil, blubber oil, and other marine animal oils have also been freely used in the adulteration of lard oil whenever the difference in price has rendered it profitable. These adulterations are of such a character that they can be detected only by the skilled microscopist and chemist. The other animal oils, both of marine and terrestrial origin, while important from a technical point of view, are of no significance in respect of edible qualities.

PART II.

POULTRY AND GAME BIRDS.

Application of Name.—The term poultry for descriptive purposes may be applied to those classes of feathered domesticated birds used for human food. It, therefore, includes practically all of the domesticated fowls. The term game bird, for the purpose of this manual, is applied to feathered animals which are wild and which are used for human food. This also may apply to almost all wild birds, since at times they practically all have been used for food purposes. Here only those in common use, both domesticated and wild, will be referred to. In connection with poultry the eggs of the birds will be considered.

DOMESTICATED FOWLS.

The principal domesticated fowls which are used for human food are chickens, turkeys, geese, ducks, and guinea hens. The most common of all is the chicken,—the next perhaps are turkeys in this country and the goose in Europe. The others are more infrequently used but are highly prized.

Chicken. — The chicken scientifically is known as *Gallus domesticus.* For food purposes the chicken is eaten at various ages. The very young chicken is commonly called a broiler and is prepared for the table at varying ages from six to twelve weeks. Young chickens are also very commonly called spring chickens, since they occur in greater abundance in the spring than at any other time. Since the introduction of the modern method of incubation, however, the spring chicken may be had at all seasons of the year. The "broiler" and "spring chicken" may be regarded as synonymous terms, though the larger chicks are usually called spring chickens instead of broilers.

Full Grown Chickens.—The full grown chicken is better suited for food when still young. The flesh loses flavor and gains in toughness as the chicken grows older. There is no legal limit fixing the division of chickens into different classes with respect to age and the only criterion is the price and taste of the consumer. There is, perhaps, no objection to the use of old chickens for food purposes, provided they are not sold fraudulently as young chicks. The size and toughness of the pieces one often secures when ordering spring chicken is an indication that the age limit is not very definitely established. Both hens and roosters are used for food purposes, but especially the young roosters are devoted to food purposes while the young hens are often kept for the production of eggs.

Preparation of Chickens for Food Purposes.—In former times, when the chickens of commerce were derived chiefly from the farm, no special preparation was made before the chicken was marketed. The eggs were hatched in the old-fashioned way by the hens and the chicks sold to hucksters or in market, at various ages and without any special preparation or control. All this has been changed in later times by the introduction of scientific methods of breeding poultry. It has been demonstrated that the breeding and care of poultry

Fig. 12.—Chicken House, Rhode Island Experiment Station.

require as much scientific and economic attention as is devoted to any other successful business.

The Incubator.—The introduction of the incubator for the hatching of eggs with the other necessary arrangements for the caring for young chicks has perhaps done more than any other one thing to revolutionize the method of preparing poultry for the market. By the use of the incubator the hatching of chicks is regulated with the utmost degree of nicety. A larger percentage of eggs produce chicks and the expense of the incubating process is greatly diminished. The incubator is in its widest significance a thermostat in which the eggs may be placed and maintained constantly at the temperature of the hen's body, namely, about 102 degrees F. The arrangement of the chicken house and the other environments of the young chick are shown in Fig. 12.

Care of Young Chicks.—The principal points in the care of young chicks are fresh air, freedom from infection by epidemic or contagious diseases, exclusion of insect pests, even high temperature, and abundance of food. The young chick is especially sensitive to low temperatures and must be protected from cold, especially from cold rains. For this reason the chicks, after hatching, must be kept, if it is not summer time, in a room where the temperature can be regulated until they have acquired some degree of strength and vitality. The temperature of the chicken house for the young birds should not be lower than 85 or 90 degrees F.

A temperature of about 102 degrees F. is found very favorable to the development of the chicks in the eggs, although the temperature may sometimes fall to 101 or rise to 103 degrees F. without materially affecting the results. Experiments show that too low a temperature arrests the development of the chick. On the contrary there seems to be no indication that an increase of heat, up to 103 degrees F., has any tendency to kill the chick in the last stages of development. It is found best in all cases to set the eggs in the incubator as soon after they are laid as possible. Where the age of the egg is not known it should be carefully candled, that is, held up between the eye and a light in order to determine its condition. In old eggs, the yolk, on candling, becomes more or less diffused with the white and such eggs are to be rejected for incubator purposes as they are not likely to produce chickens. The fertility of the egg must also be assured before placing in the incubator. An unfertilized egg is so much loss in the incubator since it might have been used for food purposes, since the egg, for marketable purposes, when fresh is just as good as a fertilized egg. It is an observed fact that the complete fertilization of the egg, that is, the proper union of the male and female germ cells, is not always complete at the time the egg is laid, but the mingling of the two elements takes place under proper conditions afterwards. The development will also depend upon the vitality of the germ and its component parts. Just, for instance, as the color of the feathers, the size of the body and the general character of the chick may be inherited from either parent, so the vital qualities are much more strongly shown in some eggs than in others. The proper germination of the egg may also be improved by many of the conditions of environment. In the case of eggs, any slight change which would interfere with the functions of the yolk or albumin, both of which are extremely sensitive to change, would interfere with the growth of the embryo either by depriving it of food or subjecting it to other conditions in which its vitality would be diminished or destroyed. The fertilized egg may be separated from the non-fertilized also by candling. At the Rhode Island station it is found that a very good light for candling is the ordinary calcium carbide bicycle lamp, placed in a proper candling box. This is a strong white light quite equal in power to the electric incandescent light and is not so trying to the eyes.

When eggs which have been submitted to incubation permit light to shine through and show the yolk suspended in the upper half of the center as a clearly defined mass, which quickly reassumes its position in turning the egg with its long axis nearly horizontal, they are probably infertile or sterile. When, on the contrary, the yolk assumes indefinite outlines, approaching near the upper portion of the shell at the large end or appears with a thick spur upon its upper side, it may be regarded as having started to incubate. In the later stages the embryo can be plainly seen, because it becomes opaque and cuts off more of the light. In the incubation of eggs the candling is resorted to during the first few days of the experiment in order that the unfertilized eggs may be separated. The best time for the candling, if it is practiced only once, is on the sixth or seventh day of incubation. By that time all the eggs which are fertilized will be so changed as to be easily recognized by the candling process. Experience has shown that eggs which are more than two weeks old are not profitable for use in incubators since the percentage that does not hatch is so large. The incubating part of the plant is sometimes placed in the cellar over which the brooding house is built.

The brooding of young chicks is of the utmost significance. In Europe the changes in temperature are much less violent than in this country. The principal brooding houses in the United States are in the North where the temperature often falls in winter to below zero while in the summer it may rise to blood heat, a difference of over 100 degrees F. For this reason the incubating houses in the United States are often placed in cellars where the uniform conditions of temperature are more easily secured. There is no objection to this location provided proper care be taken to secure ventilation and the proper content of moisture in the atmosphere. In Great Britain the incubating houses are usually placed above ground instead of in cellars. The mean range of temperature in an incubating room in Great Britain, from March 12, 1903, to March 30, 1904, was 10 degrees. The highest temperature registered was 70 degrees on the 24th of June and the lowest 42 degrees in January. The humidity of the air was also quite constant, the lowest degree of humidity being 59 and the highest 94. These data show a very even temperature in the room itself. Of course the temperature in the incubator is necessarily greater, being that already referred to, namely 102 degrees.

Early Market.—One principal object in the raising of chicks is to force them to an early maturity in so far as size and palatability are concerned. The sooner the young broilers can be made ready for the market the more economy there is in their production. To this end they ought to receive a more abundant and specially prepared kind of food than if they were intended for ordinary farm purposes. In other words, the forcing process should be pushed as far as possible without interfering with the health and normal functions of the bird. Foods which are nutritious and stimulating and promote vigorous growth should be employed. Birds prepared in this way for the market are extremely tender and palatable and bring the highest prices where their merits are recognized.

Artificial Feeding.—Where chickens of greater age are prepared for the market they are subjected, during the last two or three weeks previous to sale, to a forcing process in order to produce more fat and make their flesh more palatable. To this end the chickens are fed from time to time mechanically by passing a tube into the craw and forcing the food therein. Fowls prepared in this way bring high prices in the market and the largest profits to the growers. It is a method, however, which is not used in the raising of the ordinary poultry found on the market.

Preparing Chickens for the Market.—Chickens are sold in four different conditions in the markets of this country. First, they are offered alive. A great many purchasers prefer to get their poultry in this way because they can then be certain that it has not been long killed and kept in cold storage or preserved by means of chemicals. It is a very common custom for consumers to have their own chicken coops and buy a number of birds at a time and fatten them particularly for their own use. Under the present system of law this method is highly to be commended as a certain way of knowing the age of the poultry consumed. With proper municipal and state regulations of the markets it would not be necessary for the consumer to go to this trouble since when rigid inspection and certification are established, the age of the chicken offered on the market can be easily ascertained. Until such time comes, however, on the part of the consumer, the desirability of securing chickens alive cannot be denied.

Freshly Killed Chickens.—Chickens which have been killed within twenty-four or forty-eight hours and properly kept may be regarded as freshly killed. There is a very wide-spread opinion, and probably founded on reliable experiments, that fowls are better if they are kept some time after slaughter, provided they are kept in a proper way. In the winter time it is customary, especially in Europe, to hang the fowl for a week or ten days exposed to the ordinary temperature, before consumption. This, of course, is a practice which could not be indulged in in warm weather. Fowls, however, can be hung in cold storage even in the summer time and with the same advantage which accrues by hanging them in ordinary temperature in the winter time. Just how long fowls should be kept after slaughter in this way in order to secure a maximum degree of palatability has not been scientifically determined. There is evidently a limit beyond which the keeping of slaughtered fowls should not be indulged in. If a low and even temperature could be secured it may be certain that the hanging of the fowl for a week or ten days is not too long. The temperature, however, should not be much above the freezing point.

Freshly killed chickens are offered in two forms, namely, drawn and undrawn. The proper method of keeping a slaughtered chicken has been the subject of very lively discussions. There are many who are advocates of the exposure of the chicken in the undrawn state asserting that in this condition it is less exposed to infection and keeps better during the necessary time elapsing between slaughter and consumption. This argument is advanced chiefly by dealers. On the other hand the consumer, as a rule, is in favor of having the chicken drawn before it is exposed for sale, that is, as soon as it is slaughtered. There is perhaps much to be said on both sides of this question. If, however, chickens are to be secured by the consumer within forty-eight hours after slaughter there can be no very great danger of infection by having them undrawn. The subject is one of sufficient importance to warrant an extended scientific investigation and upon this investigation the municipal and state regulations for the sale of poultry can be based. It is not wise in such cases to be swayed solely by prejudice or sentiment but rather by the facts which can be ascertained by unbiased scientific investigation. Because a chicken weighs more undrawn is probably one of the reasons why dealers prefer them in this state. It may be said, too, that the walls of the intestines are so impenetrable that there is no danger of bacterial contamination. But the keeping of chickens with the intestinal contents undisturbed does not appeal to the imagination of the consumer any more than would the freezing of the carcass of a beef or hog with the viscera remaining in it. The most recent investigations, however, have shown that properly packed, undrawn poultry can be kept from six to nine months without danger of intestinal contamination. If poultry are drawn before storage it is highly important to avoid all contamination of the cut surfaces. Experiments have shown the advisability of packing drawn poultry in tin cartons, carefully closed. Fowls thus treated preserve to a remarkable degree their freshness and palatability. In any case the consumer should be allowed the choice in the matter which, at the present time, is not the case in many parts of this country where only undrawn poultry is exposed for sale.

Poultry in Cold Storage.—Whenever a fowl is kept for a longer period than the week or ten days above referred to for the purpose of improving its flavor and palatability it is necessary that it be placed in cold storage. This method of keeping poultry or other foods is wholly unobjectionable unless carried to excess. Poultry is a food product which under the present scientific methods of production can be furnished in a fresh state all the year. The necessity for cold storage, therefore, is not so apparent in this case as in that of fruit and other perishable foods. It appears then that cold storage should only be extended to that limit necessary to secure its delivery to the consumer. There can scarcely be any excuse for the placing of poultry in cold storage at certain seasons of the year when they are slightly less in price by reason of the abundant production than at other seasons. The methods of producing poultry are such at the present time that this excess in supply can easily be avoided on the part of the producer and thus maintain an even price and an even supply the year round. The producer as well as the consumer is benefited by such a condition. The necessity, often, for cold storage in the limited sense above referred to is acknowledged by all and a reasonable degree of time in cold storage cannot be regarded as in any way measurably harmful with reference to the character of the product. It is probable that as long as four or six months may be regarded as a justifiable limit for securing a proper market for poultry in cold storage though the exact length of time in which it may be left in cold storage will be determined only by careful scientific investigation. There seems to be no necessity whatever for carrying fowls for a longer period and especially, as has been known, for a year or even two years. The deterioration, even if the temperature is far below the freezing point, is very marked during these long periods of time and actual danger may accrue to the consumer in the possible development of poisonous degradation products in the flesh. Municipal, state, and national regulations should be of a character to inform the consumer of the exact length of time which the poultry he proposes to purchase has been in cold storage. This is the least which the consumer has the right to know and is a right which the producer and packer should concede without discussion. The unwillingness which has been manifested on the part of dealers in poultry to make public the length of time which it has been in cold storage is of itself a suspicious condition. The argument is constantly heard that the length of time poultry has been in cold storage does not impair its palatability or wholesomeness. If this be true then a statement of the length of time cannot in any way injure the market. But to this reply is made to the effect that if the consumer is told the fowl has been in cold storage a certain length of time he will not purchase it. To this the evident answer is,—why should you deceive the consumer by selling him an article which if he knew its character he would not buy? It is evident that such deception is nothing more nor less than obtaining money under false pretenses. The remedy for the evil of cold storage is the label which will indicate the length of time which has elapsed since the slaughter of the fowl.

There is, perhaps, no greater blessing which has been conferred upon mankind during the last quarter of a century than the development of cold storage methods of preserving food. The continued prosperity and benefits of this business depend upon a thorough study of the conditions attendant thereon and the elimination of any evil which may be incident thereto. When this is accomplished the absolute confidence which the consumer will have in cold storage will be such that the magnitude of the business will be immensely increased. Thus the interests of the consumer and the dealer are one and they should work together to promote their common good.

Composition of the White Meat of a Chicken.—The meat of a chicken, carefully prepared in the laboratory of the Bureau of Chemistry, was analyzed by separation into the white and dark portions. The composition of the two meats is as follows:

	Water. Percent.	Water in Fat-free Substance. Percent.	Fat. Percent.	Protein. Percent.	Meat Bases. Percent.
White meat,..........	61.38	75.08	18.25	17.06	.37
Dark meat,...........	59.48	78.44	24.16	15.94	1.03

The above data show that there is a notable difference in the composition of the white and the dark meat. The white meat has much less fat and a correspondingly larger quantity of protein. The quantity of water in the two classes of meat is not very different although there is a slightly less quantity in the dark meat. The dark meat has a much larger proportion of meat bases but as these bases are often considered of little value and sometimes degenerate into poisonous constituents it is seen from this point of view that the white meat is to be preferred to the dark meat.

Preserved Chicken.—Practically the only methods of preserving chickens are the canning processes which have already been described and cold storage. Chickens may be canned in the same way as has been described for beef and in that way may be kept for a certain length of time without notable deterioration. The pickling of chicken is not very extensively practiced nor is it cured in the ordinary sense of the word, that is, by the addition of salt, sugar, vinegar, spices, and wood smoke. Chicken may also be put up in the form of potted chicken, which has already been described. Practically the only methods which are in vogue and which can be commended for preserving chicken are sterilizing or canning and cold storage. These methods, when not unduly prolonged, are open to no reasonable objection. The preserving of chickens with spices and condiments may also, perhaps, be considered as desirable provided no harmful chemical preservatives are employed. The temptation, however, to employ such preservatives is so great as not to be always resisted.

Adulteration of Potted Chicken and Turkey.—Perhaps there is no other form of potted meat, with the possible exception of pâté de foie gras, where such an opulent field for sophistication is found as in the case of potted chicken and turkey. The average composition of ten samples of alleged potted chicken and turkey, found upon the market, is shown in the following table:

Water,..	58.52	percent
Water in fat-free substance,..................	71.24	"
Fat,..	17.98	"
Protein,......................................	19.12	"
Meat bases,...................................	.96	"
Glycogen,.....................................	.26	"
Total ash,....................................	2.67	"
Of which sodium chlorid,......................	1.05	"

All but one of the ten samples contained starch but not in very considerable quantities, the largest amount being 4.13 percent.

None of the samples contained saltpeter. This is an interesting point because of the claim of the packers that saltpeter is used solely for preservation purposes. When a meat is expected to be of a white color no saltpeter is found while, on the contrary, where the meat is of a red character it is frequently found. Tin was present in four samples, doubtless due to some contamination with the solder or by corrosion of the tin can itself. Where tin is present due to the corrosion of the can itself it is always in greater abundance in the old than in the newly canned sample. It is quite certain that the contents of these packages were not made up of chicken and turkey exclusively. The characteristic odor and taste of smoked meats which are found in these packages would indicate that they are used to give flavor and aroma to the mixture. The addition of flavoring materials of this kind, or "force" meats as they are sometimes called, is not objectionable from any sanitary or dietetic point of view. It is, however, an offense against an ethical principle which must be closely followed in a case of this kind if the doors of fraud and adulteration are not to be left wide open. This principle is that no false idea by inference, omission or otherwise, should be conveyed to the consumer by the label. Some form of expression for potted meat should be used in which the label gives the principal or dominant meat in the mixture, accompanied by the statement that it is a mixture with other meats also named, spiced and flavored. Under the present condition of affairs a manufacturer who really wishes to put into potted form chicken and turkey with only spices and condiments has to undergo an unfair competition with another manufacturer who uses the same label and reduces the quantity of expensive meat to a minimum or may possibly leave it out altogether. Under the new food law this unfair competition will be prevented.

Adulteration of Chicken.—The flesh of chicken is not subjected to any very extensive adulterations. It has been claimed that preservatives are applied externally to fresh fowls but the evidence on this point is not very conclusive. There is, perhaps, little doubt that other methods have been practiced but probably without any very great vogue. The use of chemical preservatives in potted chicken is also reprehensible. In general it may be said that there is no very extensive adulteration of chicken meat. The principal objection to the commerce in preserved chicken meat is the use of old chickens, the unlimited cold storage, the failure to draw at time of slaughter, and exposure in the market in an unsanitary condition and for an indefinite time. Cheaper meats are sometimes substituted for the genuine article in potted chicken. Turkey and pork are said to be used in chicken salad.

Capons.—The castration of the male bird produces the capon, the flesh of which is very highly valued as being superior to that of the male or female chicken. Capons are much more extensively used in Europe than in the United States but are gradually coming into favor in this country. It is difficult to describe the difference between the taste of the flesh of the capon and the rooster and hen. A greater degree of tenderness and a more delicate taste characterize the flesh of the capon. In France, especially, the production of capons has been carried to its highest perfection. Caponizing should be practiced at an early date in the life of the young bird. In fact, as soon as the distinction in sex is well marked in the young chicken the removal of the testes should take place. The young fowl is laid upon its left side and the skin is exposed by pulling back the feathers and trimming them off at the proper place until the space between the first and second ribs of the right side is laid bare. An incision is then carefully made and the testes removed by instruments particularly adapted for that purpose. The operation should be done by an expert although theoretically it appears easy of accomplishment. In practice, however, it requires an expert to avoid any injury to the bird and to insure a speedy recovery. When done in the proper way, apparently no great inconvenience attends the operation. There is little blood shed and usually no inflammation when the proper antiseptic measures are provided.

Caponizing develops a bird that is readily fattened and easily prepared for the market and highly prized. The caponized bird often develops brooding instincts and when eggs are hatched by the heat of the bird the capon makes a better brooder than the hen because of the greater spread of the wings and the larger number of eggs that can be covered in the operation. The larger breeds of birds make the best capons such as the brahmas and plymouth rocks. The capons are fattened and prepared for the market as in the case of other birds. When skimmed milk is made a large portion of the diet the flesh is considered to be of greater value. The best age for marketing a capon is at about twelve months. At that time they have attained their full size and their maximum degree of excellence as a food bird. The feeding should be done upon the principles already described, namely, to keep the birds growing in the usual way until about three or four weeks before the market when the extra food is given in as large quantities as possible for quick fattening. In Europe this extra food is usually given mechanically under the forced system though in this country the mechanical method of feeding capons has not generally been introduced.

Capons bring a higher price upon the market than the other varieties of chicken, sometimes the difference being as much as four or five cents a pound. For this reason the growth of capons becomes more profitable to the farmer than that of the ordinary chicken.

Duck (*Anas boschas*).—The domesticated duck is used very largely for food in all parts of the world. Its flavor is not so highly prized as that of the wild duck but it is an excellent article of diet. The production of ducks is conducted in the same manner as the production of poultry in general. They are still chiefly grown upon the farm without any special care but the best results are obtained by the systematic growth of ducks under scientific conditions in poultry houses. The duck is not so extensively used for food as the turkey and chicken but perhaps in this country much more extensively than the goose. The price of the wild duck, however, is still sufficiently low to limit to a certain extent the production of the domesticated article.

Varieties of Ducks.—There are many varieties of ducks cultivated for the market. The Pekin is perhaps the most abundant of all. It is creamy white in color, has a long and graceful body and has been particularly bred for the market. When ready for the market the average weight of the drake is about eight pounds and the duck seven. The Aylesbury is also a favorite variety. It is said to be somewhat whiter than the Pekin in color. It is specially valued in England as a market duck. It is somewhat larger than the Pekin. Other varieties of ducks are the Rover, the Cayuga, the Gray and White Call, the East Indian, the Crested White, the colored and white Muscovy, and the Indian runner. The latter is a very small duck, being only about one-half the size of the Pekin. Usually the ducks on the market are not designated by any particular variety and, in fact, most consumers are not sufficiently acquainted with the different varieties of duck to be able to ask for any particular one. The mallard, canvas-back, and teal are common varieties of the wild duck.

Composition of the Flesh of Ducks.—The flesh of two varieties of ducks, namely the Pekin duck and the Mallard duck, was carefully separated in the Bureau of Chemistry and subjected to analysis. The composition of the meat of these two ducks is shown in the following table:

	Water.	Water in Fat-free Substance.	Fat.	Protein.	Meat Bases.
Pekin duck,	47.46	78.20	39.31	13.37	.43
Mallard duck,	69.06	75.98	7.11	19.25	.65

The above data show a striking difference between these two varieties of ducks. The Pekin duck has a large excess of fat while the Mallard duck, which is a wild duck and evidently not very fat, has a small percentage of fat and a large percentage of protein. It is evident that the flesh of wild fowl would not, except at a certain season of the year, approach that of domesticated fowls in the percentage of fat which it contains.

Goose (*Anser anser*).—The goose is not so commonly used as a food product in this country as in Europe,—the turkey to some extent has taken its place. The remarks which are applicable to the production of chickens are also applicable to the production of geese. They, perhaps, are grown more extensively in the old-fashioned way in this country than chickens or turkeys at the present time since they are used chiefly for the feathers which they produce and not for food. Goose is also considered a winter dish both in this country and in Europe. It is customary in Europe that the goose be hung even for a longer period before consumption than the chicken. Its flesh is made more tender and more palatable by this preliminary exposure. From one to two weeks is not considered too long a time in the winter for hanging in the old country. The remarks relative to cold storage of turkey and chicken apply also to the goose. The goose is, perhaps, the most easily artificially fattened of any other poultry birds. This is especially true in those regions where fatty goose livers are so highly prized in the manufacture of *pâté de foie gras*. By long-continued artificial feeding the goose is made excessively fat and the liver especially is changed in its composition by this treatment so as to make it peculiarly suitable for the production of this delicacy.

Varieties of Geese.—The varieties of geese upon the market comprise the following leading breeds. The Toulouse is perhaps the most extensively raised. It is highly prized on account of its hardihood, its size and the general appearance of its body. It is of a gray to white color and the wings are a deeper gray or brown. The legs are usually of a deep orange. When ready for the market the average weight of the gander is 20 pounds and the goose 18. Of the other common varieties there are the Embden, the African, the brown and white Chinese, the white or Canada, and the Egyptian. The latter is a small goose only weighing about half as much as the Toulouse when ready for the market. The wild goose is highly esteemed as a game bird.

Feeding of Young Geese for the Market.—The feeding of geese for the market begins as soon as the hatching is complete. The first meal of the young chicks consists of oat meal, middlings, finely chopped dandelions, lettuce or some similar green stuff, and milk. The goslings during the first week are kept indoors and should be fed four or five times a day on the mixture above named. After this they may go into a yard where there is plenty of grass, not overgrown, and they will thrive on this very well for a time without hand feeding. Not more than two feedings a day are necessary between the ages of one and six weeks where plenty of grass is at hand. During this time no better food than ground oats and skimmed milk can be used. During all this period great care is taken that the goslings are not subjected to any disease or to cold. They should be carefully housed in sanitary coops where the temperature does not sink too low and where they are protected from cold rains. After the goslings are eight weeks old they are usually able to take care of themselves in respect of food and need, perhaps, only one feeding a day. If these goslings are hatched in the early spring they may be ready for fattening for the Christmas market. The geese until shortly before the time for market are allowed to run free in a field, not too large, where there are ponds or troughs of water in abundance. In this way the frame of the goose will be sufficiently developed by the time the fattening period comes but there will have been no unusual expense in the production of the fowl until it is prepared for the market. The large frame is necessary in order that the goose may properly fatten. It usually requires about three weeks of artificial feeding to bring a goose into proper condition for the market. If the geese are for the Christmas market, about the 25th of November they are put up in sheds for fattening, for though they have been well fed during the summer and autumn they cannot be called fat geese until they have gone through a special course of nutrition. While they are confined for fattening geese require plenty of fresh air but very little light, and these conditions are procured by housing them in large airy sheds without windows. Before the fattening season these sheds are thoroughly cleaned and white-washed and the floor covered with cinders, ashes, and charcoal. This mixture is not only a good bedding but is also a good deodorizer, which is quite important. Food troughs are arranged along the walls inside the shed and troughs for water outside in such a way that the birds can reach the water but cannot get into it. Clean charcoal is to be put into the shed every day as it is constantly eaten by the geese and is valuable. The foods used are oat meal, boiled potatoes, linseed meal or other oil cakes, and plenty of milk, usually skimmed. The birds should have all of this that they can eat, for in the process we are now describing the artificial forcing of food into the craw is not practiced. In three weeks a good goose will increase four or five pounds in weight and this increase brings the goose up from an ordinary bird in good condition to one which is properly fed for the market.

The killing of geese is practiced in practically the same manner as that which is described for slaughtering fowls. A goose is a bird of large vitality and dies hard as is the case with most fowls. The feathers should be taken off the body clean, as they are valuable for commercial purposes. Any pin feathers should be cut with a sharp knife so as to make the bird look as clean as possible when brought to the market. The carcass of the goose should not be packed to send to market until it is entirely cold and in this country, especially, where the distances are great, it is advisable to send it packed in ice or in a cold storage car. The average weight of a goose about nine months old thus prepared for the market is about fourteen pounds and the flesh is certain to be more palatable at this age when fattened in the manner above described.

Domesticated Pigeon (*Columba livia*).—In the last few years the production of domesticated pigeons has been extensively practiced in this country, and especially the production of young pigeons which are known as squabs. They are rapidly taking the place of game birds at the hotels and restaurants of the country. The conditions of production, preparation, etc., are the same as those for the ordinary domesticated fowl. There are many varieties of the bird grown; some, as the carrier, for special purposes. The other principal varieties are barbs, fantails, jacobins, runts, trumpeters, tumblers, and turbits.

Turkey (*Meleagris americana*).—In general the statement which has been made regarding the production of fowls or chickens may be applied also to the production of turkeys. No further comment, therefore, is to be made under that head. The old-fashioned method of securing turkeys grown under natural conditions has, to a great extent, given way to the production of turkeys on a large scale and under scientific conditions. Turkeys, as a rule, are not eaten young, but practically full-grown. In this country the turkey is a dish which is particularly affected for festive occasions such as Thanksgiving and Christmas, though they are eaten largely throughout the whole year. The market, however, for turkeys is particularly a November and December market and the large introduction of turkeys in the market is so timed as to furnish them in proper condition for consumption during those two months.

The methods of preparing turkeys for the market, keeping them in cold storage, of hanging them previous to consumption and exposing them drawn or undrawn for sale, are subject to the same remarks as have been made in the case of chickens. Turkeys are said to be more difficult to care for, both on the farm and in the professional poultry factory, than chickens. They are more subject to disease and more difficult to bring to maturity than chickens.

Composition of Meat of Turkey.—The flesh of the turkey was separated into two portions, the white and dark meats, and these were found to have the following composition:

	Water.	Water in Fat-free Substance.	Fat.	Protein.	Meat Bases.
White meat,	55.50	74.70	25.71	18.31	1.31
Dark meat,	54.13	75.76	27.76	16.75	1.15

A comparison of these two analyses show that there is little difference in the content of water in the white and dark meat. The dark meat, as in the case of chicken, has more fat and a correspondingly less amount of protein. The quantity of protein in the meat of turkey is about the same as that of chicken. The white meat of turkey differs from the white meat of chicken more in its content of meat bases than in any other way, except that the meat of turkey contains more fat, especially the white meat, than that of chicken.

Composition of the Meat of Chicken, Turkey, Duck, and Goose.—The composition of the chicken, turkey, duck, goose, and pigeon as given by König is found in the following table:

	Water.	Protein.	Fat.	Ash.
Chicken (lean),	76.22	19.72	1.42	1.37
" (fat),	70.06	18.49	9.34	.91
Young cock (fat),	70.03	23.32	3.15	1.01
Turkey,	65.60	24.70	8.50	1.20
Duck (wild),	70.80	22.65	3.11	1.09
Goose (fat),	38.02	15.91	49.59	.48

The above data show that with the exception of the goose the percentage of fat given in the flesh of the animals is very much less than that found in our own work. Even in the fat chicken only a little over 9 percent of fat was found. It is believed that the composition of these fowls as given by the work of the Bureau of Chemistry more nearly represents the average composition in this country than the data taken from König.

Importance of Animal Food in the Growth of Poultry.—Many people suppose that poultry can live upon vegetables alone and this is probably true. Experience, however, shows that poultry does not thrive and fatten well on purely vegetable food. This fact was brought out very prominently in the experiments at the Cornell station where poultry of the same origin and character was fed two kinds of diet, one being partly of animal food and the other purely vegetable foods. The ration of the animal food consisted of Indian corn meal, wheat flour, ground oats, wheat bran, wheat middlings, pea meal, linseed meal, meat, and fresh bone. The vegetable ration consisted of pea meal, linseed meal, wheat bran, ground oats, Indian corn meal, wheat middlings, gluten meal, and skimmed milk. Before the experiment had been long under way it was noticed that the birds receiving the meat food were developing rapidly and evenly while those that received the purely vegetable diet were becoming thin and uneven in size. The authors of the bulletin say that it was sometimes almost pitiful to see the long-necked, scrawny, vegetable-fed birds, with troughs full of abundant good, wholesome food before them, stand on the alert and scamper in hot haste after the unlucky grasshopper or fly which ventured into their pen, while the contented looking meat-fed ducks lay lazily in the sun and paid no attention to the buzzing bee or crawling beetle. The vegetable-fed birds literally starved to death, at least many of them, so that only twenty of the thirty-three with which the experiment was commenced were alive at the close of the fifteen weeks of feeding.

The Forced Fattening of Poultry.—Allusion has already been made to the forced fattening of poultry secured by injecting food into the craw in larger quantities than would naturally be taken by the fowl if left to itself. There is much to be said both for and against this method of fattening. In favor of this method it may be stated that the birds fattened in this way are more highly prized by the connoisseur, are naturally fatter by reason of the enforced idleness of the birds during the fattening process, thus diminishing muscular activity, and more tender than the birds left at freedom and forced to secure their own food. From the point of view of the seller, also, the birds are heavier and the artificially fattened fowl usually brings a higher price, pound for pound, on the market. Against the method it is urged that it is barbarous, imposing upon the birds a diet far beyond normal capacity and thus tending to damage and injure the organs of the body charged with the assimilation of food and the excretion of the waste products.

The above indictment is doubtless true is almost every respect. In explanation it may be said that the period of forcing food is always a short one, rarely extending beyond three weeks, and, therefore, any injury to the organs which might be induced is not of sufficient duration to establish any real form of disease. In other words, the birds are slaughtered before any lesions of the organs are produced. The livers of the animals, especially geese, thus artificially fattened, take on an extra quantity of fat during this period but it cannot be said that they become really diseased. The fatty livers, as is well known, are used particularly in the manufacture of a mixed spiced meat known as *pâté de foie gras*

Upon the whole it is believed that no injury is done the bird by this process of feeding which could in any way be regarded as detrimental to the flesh as a food product. In regard to the apparent barbarity of the process little need be said. The slaughter of animals for human food in itself is a barbarous practice from one point of view but if this practice is justified, as it doubtless is, by the exigencies of human nutrition, the slight degree of force which is employed in artificial fattening cannot be condemned. Moreover the artificial fattening of the fowl is of necessity a somewhat limited operation and confined to those establishments that are devoted exclusively to the production of high-grade and high-priced poultry for the market. The fattening is done by experts and, in so far as the experience of feeding men in the same way is concerned, is not attended with any pain or discomfort other than that incident to a chronically full craw.

Increase in Weight.—There is a larger increase in the weight of artificially fattened poultry over those fed in the ordinary way and allowed to run free than is usually supposed. It is stated by some authors that the average increase in weight of artificially fattened birds is as much as 35 percent. There is no secret connected with the method of artificial fattening as is sometimes supposed. There are perhaps proprietary methods for preparing foods for fattening purposes but there is no secret in the mechanism of the process. In fact the process is so simple that it might be easily taught in a general way so that the farm hand would become an expert in its use and the farmer's poultry instead of being sent to market in a half-emaciated condition might be offered to the public in the best possible shape. Poultry running at large use up a large part of the value of their food in the heat and energy developed in the ordinary search for food. When confined and fed artificially this excess of heat and energy is naturally stored as fat.

Experience has shown that the artificial feeding must be a limited one and the bird must be sent to market as soon as it has reached its maximum of perfection under the process. Experience has also shown that in the artificial feeding it is best to have each bird in a small compartment to itself with the cage so arranged that the bird can put its head through a slat in front and thus receive the food from the machine without disturbing any of its neighbors. That the birds are perfectly willing to take the food in this way is evidenced by the fact that they voluntarily put their heads through the apertures to receive their food. Each individual coop must be kept scrupulously clean and disinfected and the air in the room kept perfectly fresh and sweet. Lime should be used freely in all parts of the coop house in the form of whitewash or sprinkled about the floor or upon the floors of the coops. Gypsum or ordinary land plaster is also highly prized as another form of lime which is found to be very valuable. The whitewash must be freely indulged in and at frequent intervals.

There are various forms of fattening food used in this country. Indian corn meal forms an important part. The presence of certain animal products must not be neglected in the food as it has been shown that fowls thrive better when given, in their food, a certain amount of animal matter, both of flesh and finely ground bone. The fattening food must be in the form of a finely ground paste of the proper consistency to be handled well in the machine. It is a universal practice which custom has shown to be necessary to mix with the food a certain quantity of finely pulverized charcoal, usually about three pounds of the charcoal to 97 pounds of food. Some feeders prefer to mix the paste about twenty-four hours before it is administered, believing that the slight fermentation thus produced is beneficial.

The Cramming Machine.—Various forms of machines are employed for introducing the food into the craw. The tube carrying the food is introduced into the esophagus of the bird in a manner to avoid any pain and the apparatus is so adjusted that with a single movement of the machine, usually operated by the foot, the proper amount of food is injected. The birds should be arranged according to size so that all of a certain size may have exactly the same quantity of food administered. The operator would thus be saved the difficulty of guessing the different sizes. The arrangement of the coops and the kind of the cramming machine vary greatly. In the beginning of artificial feeding the birds should not be pushed to their full capacity. An increasing quantity of food should be given up to the end of the first week or ten days before the full maximum dose is administered. In general it is found best to take the bird out of the coop for feeding, holding it under the arm so that the neck can be made perfectly straight and gently inserting the flexible tube which carries the food and thus with the single movement of a lever, filling the craw. The use of the machine, however, is found to be advantageous from a point of economy although it is claimed that the cramming of birds by means of a funnel has been found very efficacious. With a good machine an expert operator can feed about 250 birds in an hour. An important point in the fattening is that the food should be given regularly.

Slaughtering Fowls for the Market.—It is important that a uniform and proper method be used for killing fowls intended for the market. There are two methods in common vogue, namely, by bleeding and by dislocation of the neck. The method of killing is important in order that the proper method of dressing for the market may be secured. A fowl which is offered for sale ought to be attractively dressed and any brutal or defacing method of slaughter makes it impossible afterwards to render the fowl attractive to the customer.

In killing by the dislocation of the neck the operator takes the bird by the thigh and top of the wing in the left hand and the head in the right and then draws it steadily until dislocation takes place. The skin remains unbroken and no bruised effect is produced but all the blood in the body drains into the neck and remains there. This method is one especially practiced in England

Journal, Board of Agriculture, 1904–5, page 306). Where the bird is very large, as is the case with turkeys, it may require the full strength of a man in order to produce the dislocation in the manner mentioned. In this case it is often necessary to first hang the bird up by the leg to secure the best results.

In killing a fowl by bleeding it is strung up by the legs with its head hanging downward. The operator then gives it a sharp blow with a stick on the back of the head and when he has stunned it by this means he inserts a sharp knife into the roof of the mouth, penetrating the brain. He also severs the large artery of the throat by rotating the knife and the bird rapidly bleeds to death. This method of killing, it is seen, is not a very humane one. If, for instance, the sensation of the bird is not destroyed by the first blow the other process must be needlessly painful. This process, simplified somewhat by omitting the hanging, is the one commonly followed by professionals in this country. In England turkeys which are prepared for the market are plucked but not drawn. One of the newest methods of plucking is known as the Devonshire style and consists in stripping the feathers clean off the breast and thighs but leaving the neck, back and wings covered. The fowls are then tied around the legs with a strong cord in such a manner as to show the plumpness of the breast prominently.

The methods of preparation of the fowls depend largely on the demands of the market to which they are going. Some require the fowls to be clean plucked and others prefer some of the feathers left on.

Eggs.—Eggs are a common article of diet throughout the world. The eggs of domesticated fowls are those which are principally used for food, though the eggs of wild fowls, and birds and reptiles are also edible but on account of the difficulty of getting them and their rarity are not to be considered as a commercial article. The chief sources of supply are the eggs of chickens, ducks, and geese. Chicken eggs are by far the most important, duck eggs the next important, and goose eggs the least important. The eggs of fish also constitute an article of food of considerable value and are extensively used. For instance the fresh eggs of shad are used in large quantities during the whole of the shad season and are often kept in cold storage for use at other times. The eggs of sturgeon are used extensively in the fresh state and when pickled as caviar are highly esteemed throughout the world. These two kinds of eggs are probably the most important of fish eggs used for food purposes. Chicken eggs vary greatly in size according to the age and variety of the fowl. The average weight of chicken eggs is 680 grams per dozen. They vary also in color from pure white to a brownish yellow. Duck eggs are larger and also variegated in color. The average weight of duck eggs is 847.2 grams per dozen. Goose eggs are the largest of the three varieties, varying also in color. They weigh on an average 2284.8 grams per dozen. Eggs also vary greatly in shape, being generally ovoid, but some being much more spherical than others according to the species of the fowl and variety. The number of eggs which a chicken will lay varies greatly. Attempts have been made, with great success, at experiment stations, to develop chickens with high laying powers. A hen which will produce over 200 eggs a year is regarded as a high-grade fowl for egg-producing purposes. Eggs are produced more abundantly during the early spring and summer than during the winter months. One of the purposes of scientific egg producing is the development of fowls that will produce eggs more evenly throughout the whole year, thus avoiding the very great depression in the price of eggs in the spring and the excessively high price of eggs in the winter.

Composition of Eggs.—A large number of eggs have been analyzed in all quarters of the world and found to vary but little in composition in different localities, and very little also in regard to the variety of the fowl. The egg consists essentially of two portions,—an external highly albuminous portion known as the white and an internal colored portion, yellow or reddish in tint, known as the yolk. The white of an egg is composed almost entirely of albumin partially dissolved in water. The yolk of the egg is composed of albumin, fat, and a phosphorus-bearing material of high nutritive value known as lecithin. The yolk of an egg is a much richer food product than the white, containing in addition to the nitrogeneous element the fat and mineral bodies necessary to nutrition. Both the white and yolk of an egg are composed principally of water as will be seen by the following analytical data:

	Water. Percent.	Protein. Percent.	Fat. Percent.	Ash. Percent.	Calories. Per pound.
Hen,	73.7	13.4	10.5	1.0	....
Duck,	70.5	13.3	14.5	1.0	985
Goose,	69.5	13.8	14.4	1.0	985
Turkey,	73.3	13.4	11.2	0.9	850

Fresh eggs have a specific gravity of 1.089. Kept a week at 75° F. this number falls to 1.067. Strictly fresh eggs will sink in a 10 percent salt solution at 75° F.

Preservation of Eggs.—Freshly laid eggs may be preserved for several days without any notable deterioration by keeping in a cool place. The temperature of preservation should be as near the freezing point as can be secured. The vital processes are continually going on in a fresh egg and hence there is a development of a certain degree of heat due to these activities. For this reason eggs can be placed in an atmosphere below the freezing point of water without being frozen. An additional reason for this is found in the fact that the water which is present in eggs holds the albumin and other bodies in solution and the freezing point of a solution is always lower than that of the solvent alone. For domestic purposes where refrigerating establishments are not available the fresh eggs should be kept in a cool dark place where the temperature is not allowed to go above 50 or 60 degrees. At a higher temperature than this fresh eggs lose their freshness in a remarkably short time. The porous nature of the shell is a condition which favors the deterioration of the egg by the admission of air and microbes into the substance of the egg itself.

The preservation of eggs is, therefore, materially assisted by coating the egg artificially with a varnish or film of some kind which renders the egg impervious to air and water. One of the cheapest, simplest, and best of these coatings, as has already been noted, is soluble glass. This is produced by dissolving the chemical substance known as silicate of soda in water, and dipping the egg into the solution, removing and allowing to dry. The silicate of soda which is thus left in a thin film over the surface of the egg penetrates and stops the pores and renders the egg shell practically impervious both to air and water. This material has the property of becoming totally insoluble in water when it has once been dried so that even if the egg is afterwards subjected to rain or water in any form the film is not removed. Many other methods of coating eggs have been employed and are dependent upon the same principle but are perhaps not so effectual and simple as the inexpensive method above described.

Cold Storage.—Eggs either with or without the coating of the surface, usually without, may be kept for a considerable length of time without deterioration in cold storage. In this case it is advisable to reduce the temperature to the lowest possible point to retain the semi-fresh condition of the contents. Water freezes at 32 degrees, but for the reasons above mentioned the temperature at which the egg is stored may be reduced notably below 32 degrees without danger of solidifying. The eggs kept in cold storage gradually acquire a taste and aroma which are quite different from the fresh article and the period of preservation should never be prolonged, probably a month or six weeks is the extreme limit for keeping eggs which can still be regarded as having the qualities of the fresh article. In practice, eggs are kept often a very much longer time since the principal object of cold storage is to lay in a supply in the spring and summer when they are abundant and keep them over until the next winter. The average age of cold storage eggs is probably more than six months. At this time the eggs have acquired a distinctly unpleasant odor and flavor which enables even one who is not an expert to distinguish between them and the fresh article. Such eggs should not be allowed on the market except under their proper designation so that the purchaser may know the character of the product he is getting. There is a determined opposition on the part of those dealing in cold storage eggs against such marking, an opposition which can only be explained by the fact that the amount of deterioration is fully as great as specified. If cold storage eggs have not been kept long enough to develop any of the objectionable conditions mentioned above and are inferior only in respect of taste and aroma there seems to be no just reason why they should be forbidden sale. They usually bring a lower price than fresh eggs produced at the time of sale and thus are brought more readily within the means of those who are less able to pay the higher prices. Cold storage eggs are extensively used for baking purposes and in this condition escape the detection of the consumer. This appears, however, to be no just reason for their use without notice.

Broken Eggs.—An extensive industry has been practiced for many years in the product known as broken eggs. In the preparation of broken eggs at times of great abundance, the eggs are collected and broken and then mixed together in containers of various sizes, often as large as barrels, and preserved by the admixture of borax. From two to four pounds of borax are usually employed per 100 pounds of broken eggs. In this condition the eggs are kept from the time of great abundance until the time of higher prices, namely, from six to eight months, and then sent into commerce. The use of broken eggs of this kind for edible purposes is totally indefensible. While borax prevents the development of bacteria it does not entirely inhibit enzymic action and hence that subtle change of nitrogenous matter which produces poisonous bodies may go on in the presence of borax while apparently the egg itself remains undecomposed. Other preserving agents have been used in place of borax for these products, but all are open to similar objections. Broken eggs are also preserved by placing in cans and freezing. There is no objection to this practice if the eggs are fresh and are broken in such a manner as to prevent infection by contact with the exterior of the shells or otherwise. Stale, spotted, broken or otherwise unmarketable eggs should never be used. Broken eggs are used chiefly by bakers in large cities.

Dried Eggs.—The rapid drying of fresh eggs is perhaps an unobjectionable method of preservation. The drying may take place by spreading the eggs in a thin film on a dry surface, which is the usual method, or by forcing the egg product through small orifices under a high pressure into a drying chamber so adjusted as to temperature and size as to secure the desiccation of the minute particles of egg spray before they fall to the bottom. This method is perhaps the best which has yet been developed in the desiccation of such products. The egg powder thus formed is almost devoid of moisture and when properly collected and stored out of contact with the air, may be kept for a time without deterioration. Dry egg products such as have been described made from fresh eggs, may be considered unobjectionable for a reasonable length of time. Unfortunately dried products are sometimes made from decayed eggs. The same precautions are to be observed in the preparation of dried eggs as are outlined above for the broken product.

Egg Substitutes.—Many products have been put upon the market of a yellow color and containing protein under the guise of eggs. There is a number of so-called egg powders offered for making cakes, etc., which contain no egg at all. They are composed of other forms of protein matter, generally casein from milk, and colored to resemble the egg in tint. Starchy substances are also colored and sold as egg powder. These substances may be regarded as adulterations when sold under the name or in the guise of an egg product. There are no other adulterations of eggs of any consequence practiced except the simulation of egg material by such products as those just mentioned.

Poisonous Principles in Eggs.—While fresh eggs for most people form a food product entirely devoid of danger, nutritious and easily digestible, eggs may easily become injurious and even poisonous. According to experiments made by Bouchard (Scientific American, August 11, 1896, page 95), even fresh eggs, unless the sanitary conditions in which the fowls live are well cared for, may become very poisonous. The fowl producing eggs, as a rule, is not a cleanly animal, and this is especially true of the duck. Thus injurious organic material rich in microbes may contaminate the egg and the microbes may penetrate the shell thus rendering the egg unsuitable for consumption. Eggs contaminated in this way have given evidence of toxic phenonema even in a fresh state. Experiments have shown too that the food material of eggs if directly injected into the blood of an animal produces toxic effects whereas if injected into the stomach no unfavorable effects are produced. Egg albumin, that is, the albumin of the white of the egg, when fed in considerable quantities to animals partially escapes digestion and thus becomes a source of irritation and even of poisoning. There are many people who are remarkably sensitive to the influence of eggs and those who possess this idiosyncrasy are injured even by eggs which are perfectly harmless to other people. A large number of species of injurious microbes which infect eggs have been identified. These even are found in fresh eggs in the unsanitary conditions above mentioned. Eggs kept for a long while in cold storage or decayed in any way are extremely injurious. Fortunately decayed eggs are self protecting since they can only be eaten by accident. If, however, decayed eggs be eaten in diluted form by mixing with other foods they may be eaten without their characteristic odor or taste being known and thus great injury arises. It is advised in all cases where eggs are to be kept for some time even in cold storage to varnish them with some substance impenetrable to air. For this purpose, as has already been mentioned, soluble glass, which is chemically a silicate of soda, has been found extremely effective. Any of the varnishes which make the shell of an egg air tight tends to restrain the activities of bacterial life since the bacteria cannot live without air. The officials who inspect food should direct special care to the storing of eggs in order that no damage may result from keeping them too long in cold storage or otherwise. It must not be understood that poisoning by eggs is of common occurrence. In fact it is very rare. The fact that the egg itself, which is such a common article of diet, may be unsanitary and improperly kept is a matter of great concern to the consumer.

Parasites in Eggs.—The egg also when produced in unsanitary conditions may become infected with parasites. Many of these are apparently harmless, but some are injurious and even dangerous. The mere fact that parasites may exist in eggs is of itself a sufficient reason for the consumer to insist that the eggs he eats, like the milk he drinks, shall be free from all infections due solely to carelessness in production.

PART III.

FISH FOODS.

FISH.

Fish furnish a very important and useful part of the animal food of man. Both the fish growing in fresh water and in salt water are generally edible. Usually the smaller-sized fish are considered more palatable, but this is not universally the case. The large-sized fish are apt to be coarse, and have a less desirable flavor than those of smaller size. The size of the fish usually depends upon the magnitude of the body of water in which the species grow, the largest being in the lakes and oceans, the medium-size in rivers, and the smallest in brooks. Fish are known chiefly by their common names, and these names are different for the same species of fish in different parts of the country. For instance, the term trout covers a multitude of species, and, likewise, under the term sardine a large number of different species or varieties of fish are considered. There is also a large number of varieties known as salmon, perch, bass, etc.

In the following table are given the common and the scientific names of the principal food fishes used in the United States (see Report of U. S. Commission of Fish and Fisheries, 1888, pages 679–868):

Acipenseridæ:
- *Acipenser sturio oxyrhynchus*, Sturgeon.

Catostomidæ:
- *Moxostoma velatum*, Small-mouthed red-horse.

Clupeidæ:
- *Clupea harengus*, Herring.
  - *pilchardus*, Sardine.
  - *vernalis*, Alewife.
  - *sapidissima*, Shad.

Salmonidæ:
- *Osmerus mordax*, Smelt.
- *Coregonus clupeiformis*, Whitefish.
  - sp., *tullibee* or *artedi*, Ciscoe.
- *Oncorhynchus chouicha*, California salmon.
- *Salmo salar*, Salmon.
  - subsp. *sebago*, Land-locked salmon.
- *Salvelinus namaycush*, Lake trout.
  - *fontinalis*, Brook trout.

Esocidæ:

Esox lucius, Pike.

reticulatus, Pickerel.

nobilior, Muskellunge.

Anguillidæ:

Anguilla rostrata, Eel.

Mugilidæ:

Mugil albula, Mullet.

Scombridæ:

Scomber scombrus, Mackerel.

Scomberomorus maculatus, Spanish mackerel.

Orcynus thynnus, Tunny.

Carangidæ:

Trachynotus carolinus, Pompano.

Pomatomidæ:

Pomatomus saltatrix, Bluefish.

Stromateidæ:

Stromateus triacanthus, Butter-fish.

Centrarchidæ:

Micropterus salmoides, Large-mouthed black bass.

dolomieu, Small-mouthed black bass.

Percidæ:

Perca fluviatilis, Yellow perch.

Stizostedion vitreum, Wall-eyed pike.

canadense, Gray pike.

Serranidæ:

Roccus lineatus, Striped bass.

americanus, White perch.

Centropristis atrarius, Sea bass.

Epinephelus morio, Red grouper.

Sparidæ:

Lutjanus blackfordi, Red snapper.

Stenotomus chrysops, Porgy.

Diplodus probatocephalus, Sheepshead.

Sciænidæ:

Sciæna ocellata, Red bass.

Menticirrus saxatilis, Kingfish.

Cynoscion regale, Weakfish.

Labridæ:

Hiatula onitis, Blackfish.

Gadidæ:

Phycis chuss, Hake.

Brosmius brosme, Cusk.

Melanogrammus æglefinus, Haddock.

Gadus morrhua, Cod.

Microgadus tomcod, Tomcod.

Pollachius virens, Pollock.

Pleuronectidæ:

Hippoglossus hippoglossus, Halibut.

Platysomatichthys hippoglossoides, Turbot.

Paralichthys dentatus, Flounder.

Pseudopleuronectes americanus, Flounder.

Petromyzontidæ:

Petromyzon marinus, Lamprey eel.

Raiidæ:

Raia sp., Skate.

Some of the scientific names in the above list have been modified by recent research, but it is advisable to present the above classification for purpose of reference. The variations from these names will be given in the part of the discussion relating to the food value of fish, in which the classification of Jordan and Evermann is followed.

Edible Portion of Fish.—As in the case of other animals large parts of fish as taken from the water are inedible. In the preparation of fish the head is usually removed, especially if the fish be of any size, and the entrails rejected. If the fish be scaly, the scales are also removed. The latter vary very greatly in different specimens according to species, size, etc. Usually the edible portion of the fish is larger in quantity than the inedible, though this is not by any means universally the case. Taking fish of all kinds together it may be said that from 55 to 60 percent of the total weight is edible. This, of course, excludes the bones as well as the other portions already referred to.

Principal Constituents of the Flesh of Fish.—In the flesh of cattle, swine, and other edible animals already mentioned it is seen that the protein is the principal part of the edible portion. In many kinds of meat, however, the fat is the principal portion, as in bacon. In the flesh of fish the albuminoids occupy a more prominent part than in the flesh of domesticated animals or game. In other words the proportion of fat, which is one of the principal ingredients of the flesh of other animals, is less than in the other kinds of flesh. The protein in the water-free substance often constitutes over 90 percent of the total matter, and rarely falls below 80 percent. The next most important constituent of the dry flesh of fish naturally is the fat. The average content of fat in the dry flesh of fish is under 10,—it rarely goes above 20 and sometimes falls as low as 2 or 3 percent. The mineral content of the dry flesh of fish is quite constant. It rarely falls below 4 or goes above 8 percent; 5 percent may be regarded as a fair average content of mineral matter. The mineral matter consists chiefly of phosphate of potash and lime, together with some common salt. In the analyses made by Atwater, adopted in the following pages, he grouped together the fish analyzed by the proportion or quantity of the edible portion or flesh which they contained. Groupings were also made on account of the dry substance in the flesh and the proportion of water and fat which they contained. These tables are of value showing in a general way the relative food importance of the different specimens of fish. This classification is given in the following table:

Classification of Fishes by Percentages of Flesh, Chiefly Muscular Tissue in Entire Body.

Kinds of Fish.	No. of Specimens Analyzed.	Flesh.
Containing 60 percent or over of flesh.		*Per-cent.*
Spanish mackerel	1	65.4
Salmon	4	64.7
Red snapper	1	60.0
Containing between 60 and 70 percent of flesh.		
Smelt	2	58.1
Pike (pickerel)	1	57.3
Cisco	1	57.3
Butter-fish	1	57.2
Spent salmon	2	56.4
Mackerel	5	55.4
Pompano	2	54.5
Lamprey eel	1	54.2
Herring	1	54.0
Pickerel	2	52.9
Spent land-locked salmon	2	52.7
Turbot	1	52.3
Brook trout	3	51.9
Muskellunge	1	50.8
Alewife	2	50.5
Containing between 50 and 40 percent of flesh.		*Per-cent.*
Shad	7	49.9
Weakfish	1	48.1
Cod	2	47.5
Whitefish	1	46.5
Small-mouthed black bass	1	46.4
Striped bass	5	45.1
Large-mouthed black bass	1	44.0
Sea bass	1	43.9
Winter flounder	1	43.8
Lake trout, "Mackinaw trout"	1	43.7
Kingfish	1	43.4
Pike perch, "Wall-eyed pike"	1	42.8
Mullet	1	42.1
Tomcod	1	40.1
Porgy	3	40.0
Containing between 40 and 30 percent of flesh.		
Black fish	2	39.9
White perch	2	37.5
Yellow perch	1	37.3
Pike perch	1	36.8
Red bass	1	36.5
Sheepshead	1	34.0
Common flounder	1	33.2

Classification of Fishes by Proportions of Fat in the Flesh of Specimens Analyzed.

Kinds of Fish.	No. of Specimens Analyzed.	Water.	Fats.
Containing over 5 percent of fats.		*Per-cent.*	*Per-cent.*
California salmon	2	63.6	17.9
Turbot	1	71.4	14.4
Salmon	5	63.6	13.4
Lamprey eel	1	71.1	13.3
Lake trout	2	69.1	11.4
Butter-fish	1	70.0	11.0
Herring	1	69.0	11.0
Shad	7	70.6	9.5
Spanish mackerel	1	68.1	9.4
Salt-water eel	2	71.6	9.1
Pompano	2	72.8	7.6
Mackerel	6	73.4	7.1
Whitefish	1	69.8	6.5
Halibut	3	75.4	5.2
Porgy	3	75.0	5.1
Containing between 5 and 2 percent of fats.			
Alewife	2	74.4	4.9
Mullet	1	74.9	4.6
White perch	2	75.7	4.1
Sheepshead	2	75.6	3.7
Spent salmon	2	76.7	3.6
Cisco	1	76.2	3.5
Spent land-locked salmon	2	78.5	3.0
Striped bass	6	77.7	2.8
Muskellunge	1	76.3	2.5
Small-mouthed black bass	1	74.8	2.4
Weakfish	1	79.0	2.4
Small-mouthed red-horse	1	78.6	2.4
Brook trout	3	77.7	2.1
Containing less than 2, the majority less than 1 percent of fats.		*Per-cent.*	*Per-cent.*
Sturgeon	1	78.7	1.9
Smelt	2	79.2	1.8
Skate	1	82.2	1.4
Blackfish	4	79.1	1.4
Bluefish	1	78.5	1.3
Red snapper	3	78.5	1.0
Large-mouthed black bass	1	78.6	1.0
Kingfish	1	79.2	1.0
Pollock	1	76.0	0.8
Yellow perch	2	79.3	0.8
Pike perch, gray pike	1	80.9	0.8
Hake	1	83.1	0.7
Common flounder	2	84.2	0.7
Grouper	2	79.4	0.6
Pike (pickerel?)	1	79.8	0.6
Sea bass	1	79.3	0.5
Pike perch, wall-eyed pike	1	79.7	0.5
Pickerel	2	79.7	0.5
Red bass	1	81.6	0.5
Tomcod	1	81.6	0.4
Cod	5	82.6	0.4
Winter flounder	1	84.4	0.4
Haddock	4	81.7	0.3
Cusk	1	82.0	0.2

CLASSIFICATION OF FISHES BY PROPORTIONS OF WATER-FREE SUBSTANCE IN THE FLESH OF SPECIMENS ANALYZED.

Kinds of Fish.	No. of Specimens Analyzed.	Water-free Substance.
Containing over 30 percent of water-free substance.		*Per-cent.*
California salmon	2	36.4
Salmon	5	36.4
Spanish mackerel	1	31.9
Herring	1	31.0
Lake trout	2	30.9
Whitefish	1	30.2
Containing from 30 to 25 percent of water-free substance.		
Butter-fish	1	30.0
Shad	7	29.4
Lamprey eel	1	28.9
Turbot	1	28.6
Salt-water eel	2	28.4
Pompano	2	27.2
Mackerel	6	26.6
Alewife	2	25.6
Small-mouthed black bass	1	25.2
Mullet	1	25.1
Porgy	3	25.0
Containing between 25 and 20 percent of water-free substance.		
Halibut	3	24.6
Sheepshead	2	24.5
White perch	2	24.3
Pollock	1	24.0
Cisco	1	23.9
Muskellunge	1	23.7
Spent salmon	2	23.3
Striped bass	6	22.3
Containing between 25 and 20 percent of water-free substance—Continued.		*Per-cent.*
Brook trout	3	22.3
Bluefish	1	21.5
Red snapper	3	21.5
Spent land-locked salmon	2	21.5
Small-mouthed red-horse	1	21.4
Large-mouthed black bass	1	21.4
Sturgeon	1	21.3
Weakfish	1	21.0
Blackfish	4	20.9
Smelt	2	20.8
Kingfish	1	20.8
Yellow perch	2	20.8
Sea bass	1	20.7
Grouper	2	20.6
Pickerel	2	20.3
Pike perch, "wall-eyed pike"	1	20.3
Pike (pickerel?)	1	20.2
Containing between 20 and 15 percent of water-free substance.		
Pike perch, gray pike	1	19.2
Tomcod	1	18.5
Red bass	1	18.4
Haddock	4	18.3
Cusk	1	18.0
Skate	1	17.9
Cod	5	17.4
Hake	1	16.9
Common flounder	2	15.8
Winter flounder	1	15.7

In the scientific names of the food fishes described in the following pages and in the description of their habits, methods of spawning, geographic distribution, etc., the classification of Jordan and Evermann* has been followed.

Alewives.—A fish belonging to a genus very close to that to which the herring belongs is known as alewife. The name of the genus is *Pomolobus*. It is commonly known as a herring. For instance, the fresh-water skipjack or blue herring,—the tailor herring or hickory shad,—and the real alewife or branch herring are all common species of this genus. One specimen of this genus is the fresh-water skipjack or blue herring (*Pomolobus chrysochloris*) found in the larger streams in the Mississippi valley and also in Lake Erie and Lake Michigan. It is strictly a fresh-water fish, but has also been found in salt water on the Gulf coast. The tailor herring is found along the Atlantic coast from Cape Cod to Florida. In the Potomac river it is known as tailor shad or "fresh-water tailor," and is highly esteemed as a food fish in Washington and vicinity. Their value is found rather in their coming earlier than the

* "American Food and Game Fishes," by Jordan and Evermann, 1 vol., large 8vo, pp. i to l + 1 to 572. Twelve colored plates and several hundred full-page plates from photographs from life and text-figures. Doubleday, Page & Co., New York.

shad than in their true value, for as soon as the shad come in great abundance there is no longer any market for the alewife.

Composition of Alewife.—

	Fresh.	Dry.
Water,	74.41 percent	
Protein,	19.17 "	75.87 percent
Fat,	4.92 "	19.08 "
Ash,	1.47 "	5.78 "

This fish, it is seen, has very much less oil in it than the true herring,—in fact, only a little more than one-half as much. It, however, has a correspondingly larger percentage of protein.

The tailor herring and hickory shad are distributed along the coast from Cape Cod to Florida. The branch herring (*Pomolobus pseudoharengus*) is found along the Atlantic coast as far south as Charleston, entering fresh-water streams to spawn, usually two or three weeks ahead of the shad. It occurs also in Lake Ontario and in several of the small lakes in northern New York in which it is land-locked. The summer herring (*Pomolobus æstivalis*) also occurs along the Atlantic coast.

Anchovy.—The anchovy is a small fish which is eaten more as a relish in the pickled state than in the fresh state, and is highly prized by many connoisseurs. Anchovies of various species are found on both the Atlantic and Pacific coasts,—on the Atlantic coast from Cape Cod to Brazil and on the western coast from southern California southward. These fish reach a length of from 2 to 7 inches. The very small ones are sometimes known as "whitebait." Those that are pickled and used for food are usually from 3 to 6 inches in length. Pickled sprat is called anchovy in Norway and Sweden.

Composition of Preserved Anchovies.—

Water,	57.8 percent
Protein,	22.3 "
Fat,	2.2 "
Ash (principally salt),	23.7 "

Black Bass.—Two species of black bass are well known to the American fisherman and to the American cuisine. The one is called the small-mouth black bass (*Micropterus dolomieu*) and the other the large-mouth black bass (*Micropterus salmoides*). These fishes are found in the fresh waters of the United States, especially in the northern portion, almost everywhere. Both species have been propagated both by the National and State Fish Commissions. Especially have they been introduced into the northeastern waters where they originally did not occur, or only in small numbers.

Bluefish.—The bluefish (family Pomatomidæ) is one of the valuable food fishes of our Atlantic coast. It is a voracious, carnivorous fish, and apparently loves to destroy as well as to eat. It is stated that the bluefish copies after the style which was once said to be in vogue in Rome, viz., when its stomach is filled it disgorges it for the purpose of eating a new ration. The size of the bluefish runs from 3 to 5 pounds, though occasionally very much larger examples are taken. As a food fish it is said to rank in the estimation of the connoisseur with pompano and Spanish mackerel. The bluefish is one of the popular fishes in all the large markets of the Atlantic coast. The flesh has a fine flavor, but, like the pompano, it does not keep well.

Composition.—

	Fresh.	Dry.
Water,	78.46 percent	
Protein,	19.02 "	90.13 percent
Fat,	1.25 "	5.79 "
Ash,	1.27 "	5.91 "

A comparison of the flesh of this fish with the pompano shows that it is particularly a protein food, the fat being even less abundant than the mineral matter. It, therefore, is not so well balanced a ration as the flesh of the pompano and other fish in which the fat forms a considerable portion of the edible matter.

Carp.—The carp is a fish used very largely for food purposes, but it has not the fine flavor and character of most fishes. The carp cultivated in America is known as the German carp (*Cyprinus carpio*).

The carp belongs to the large family of fishes known as the minnows or Cyprinidæ. This family is a large one, having about 200 genera and more than 1000 species, all of which are inhabitants of fresh water in North America and Eurasia. None of this family is highly regarded as food in the sense of flavor and aroma, except, perhaps, some of the smaller species. The nutritive value of the carp, however, is probably as great as that of any, but it is coarser and less attractive to the taste. Some of the most common species of this family are the dace, fallfish, river chub, creek chub, squaw-fish, and roach.

Catfish.—Catfish, of which there are many species, belong to the family of Siluridæ, and are among the most common fresh-water fishes found in the United States. They occur in small as well as large fresh-water streams and lakes, and it is one of the species which the American boy most delights in catching with hook and line. The catfish is most conveniently taken after night, and the smouldering fire and small boy on the bank of a stream is a frequent picture of American country life. There are more than 100 genera of the catfish family and about 1000 species. Only about one-third of the species inhabit salt water. The North American fresh-water species are confined particularly to the Atlantic coast, the Mississippi valley, and the Gulf states. There are no native species of the catfish in the fresh waters of the Pacific coast. The blue catfish, known as the Mississippi catfish, is the most prominent species (*Ictalurus furcatus*). It is found particularly in the Mississippi river and its large tributaries. Sometimes it grows to an immense size, individuals having been found reaching 150 pounds in weight. If the stream in which the catfish lives runs north and south it will be found in the southern part of the stream in the winter and in the northern part in summer. This fish is highly prized for edible purposes. In the small streams the catfish is correspondingly small and weighs from less than one pound to two or three pounds only. The small catfish, especially in the small streams tributary to the Ohio and Mississippi, has edible properties which are far superior to the large catfish growing in the rivers themselves.

The catfish of the small streams and lakes are commonly known as bull-heads, since the head is large and wide. The name of the most common or best known species is *Ameirus nebulosus.* This species is found from Maine westward and southward. In Pennsylvania it is known as the Schuylkill cat, and everywhere generally throughout the country as a small catfish.

Codfish.—One of the most famous food fish of the American waters is the codfish. It is a widely distributed fish. There are said to be about 25 genera and 140 species. The codfish is particularly a fish of the northern waters. Only one genus is found in fresh-water lakes and streams.

The Common Cod.—The common codfish (family Gadidæ) is the species *Gadus callarias.* It is rarely found south of the Virginia coast, but is especially abundant off the New England and Newfoundland coast. The great center of the codfish industry is in the vicinity of Newfoundland. Gloucester, Massachusetts, is the principal town devoted to the codfish industry in the United States. The cod is an omnivorous fish and especially fond of crustaceans, mollusks, and small fish. It also eats vegetation, and it is stated by Jordan and Evermann that all sorts of things have been found in cod stomachs, such as oil cans, finger rings, rubber dolls, rocks, pieces of clothing, etc. The livers of the cod, especially those of Norwegian origin, are extremely valuable, being the source of cod liver oil, which is considered by many to be the most valuable medicinal food known. Cod liver oil, while not palatable, is highly nutritious. The cod livers contain, according to some authorities, over 60 distinct chemical substances, many of which are highly important for their medicinal qualities. The cod move in schools, but not in such dense bodies as the mackerel, herring, and menhaden. Their movements are largely controlled by the temperature of the water and their desire for food. This species probably does not reach a greater length than 3 feet and a weight of more than 25 pounds. The average weight of the large-size cod in New England waters is about 15 pounds and on the Grand Banks of Newfoundland 20 pounds. The average weight of the small-size cod in these waters is about 12 pounds. It is one of the most prolific of fishes. The ovaries of a 21-pound cod were found to contain 2,700,000 eggs and of a 75-pound cod 9,100,000 eggs. The eggs are very small and require about 337,000 to make a quart. The cod is one of the most valuable of all fishes from a commercial point of view and also on account of international relations. On some occasions this country has apparently been on the verge of war with Great Britain respecting questions relating to the fisheries on the banks of Newfoundland. The U. S. Bureau of Fisheries has probably done more to propagate the cod than any other variety of fish. More than five hundred million cod fry have been liberated at different times by the Bureau and the number in one year has approximated 100,000,000. The color of the common cod is green or brown, but is subject to very great variations,—sometimes it is yellow or red and a variety of tints are assumed.

Composition.—

	Fresh.	Dry.
Water	82.64 percent	
Protein	15.77 "	95.13 percent
Fat	.36 "	2.07 "
Ash	1.23 "	7.08 "

These data show that the flesh of cod fish is perhaps the most exclusively nitrogenous of any of the more abundant food fish. The quantity of fat contained therein is less than $\frac{1}{40}$ of the total weight. The flesh of the fresh cod is more largely composed of water than that of the ordinary fish, containing approximately 83 percent of that substance. The flesh of the cod itself is an unbalanced ration, and needs to be eaten with butter and potatoes in order to make a complete ration. The hake, which is sometimes substituted for the cod without the knowledge of the purchaser, has very much the same chemical constituents, containing—

	Fresh.	Dry.
Water	83.11 percent	
Protein	15.24 "	91.00 percent
Fat	.67 "	3.97 "
Ash	.96 "	5.77 "

It is seen that there is very little difference in the chemical composition of these two fishes. This, however, does not justify the substitution of the hake for the cod, inasmuch as the hake is inferior in palatability to the cod.

Salted and Dried Cod.—In the United States the cod is particularly devoted to the use of curing and salting, and in this cured state is even more highly valued, especially for the making of codfish balls, than it is in its fresh state. The old-fashioned method of salting and smoking produced a flesh of very high flavor, yielding under proper treatment in the kitchen a most delicious base for the fish ball. Under the modern system of quick curing, the salting and smoking have largely disappeared and the fish are cured in brine, and with the help of borax a product is produced which is less palatable than the old-fashioned cured fish.

Composition of dry Salted and Dried Cod.—

Protein	45.65 percent
Fat	.53 "
Salt	53.82 "

These data show that more than half of the weight in the water-free state is composed of salt. The codfish is also put up as boned fish in which nothing but the flesh is found, as desiccated cod, as shredded codfish and in various other forms.

Average Composition of Codfish Balls.—

Water,	65.43	percent
Solids,	34.57	"
Nitrogen,	1.05	"
Phosphoric acid,	.25	"
Sulfur,	.10	"
Fat,	7.84	"
Ash,	4.05	"
Protein,	6.58	"

The difference between the composition of the fish balls and the average composition of fish is clearly brought out by the data recorded. In the average composition of fish the sum of the fat, ash, and protein is greater than the solids obtained by difference by 0.36 percent. In the codfish balls the sum of the ingredients mentioned is less than the solids by difference by 16.10 per cent. This is due to the added potato, salt, etc.

Average Composition of Shredded Codfish.—

Water,	46.52	percent
Ash (chiefly salt),	22.81	"
Fat,	.33	"
Protein,	30.85	"

Eels.—The common eel is a fish which is extremely long in proportion to its size and has the general appearance, to the uninitiated, of a snake. The resemblance of the eel to a snake in shape is probably one of the reasons why it is not more highly valued as a food. The eels, perhaps, are not to be considered as true fish. The common eel (*Anguilla chrysypa*) is widely distributed throughout most parts of the United States, especially the eastern part. It extends southward as far as the West Indies, and is found in more or less abundance on the Gulf coast. Although a salt-water fish, it differs from most other eels in its penchant for ascending fresh-water streams. It often goes to the very headwaters, especially in the rivers of the Atlantic coast and Mississippi valley. Eels are often found in lakes which seem to have had no communication with the sea, which shows that they are able to surmount barriers which seem impossible to cross. Jordan and Evermann claim that the eel is really a fresh-water fish and that its real home is in the fresh-water rivers and lakes, and that it runs down to salt water only at spawning time, thus showing a quality or characteristic exactly opposite to that of the salmon and shad, which are true salt-water fish and come into fresh waters for spawning. Eels, like the carp, are more or less scavengers, feeding upon all manner of refuse, especially dead fish. They are very destructive of other fish, especially of young shad and herring. When nets are placed for shad and herring and the fish are caught therein the eels often invade the net, and when it is drawn it is filled largely with the skeletons of the fish, the flesh of which has been removed by the eels. Eels have a high value as food fish, both on account of their nutritive value and their flavor. The average length of the eel is from 2 to 3 feet, though much larger examples are sometimes found.

Composition of the Eel.—

	Fresh.	Dry.
Water,	71.60 percent	
Protein,	18.28 "	65.25 percent
Fat,	9.11 "	31.92 "
Ash,	1.01 "	3.60 "

These data show that the eel is rather richer in fat than the majority of fish, although there are some that exceed it in this constituent.

Conger Eel.—The conger eel belongs to the family Leptocephalidæ. It inhabits salt water only, is scaleless, and grows to much larger sizes than the common eel, sometimes as long as 7 or 8 feet. It is not used for food in the United States, but is to some extent in Europe and the West Indies. On the east coast of the United States they do not occur very frequently. Only a few species are known, and these are of small extent and have little food value.

Summer Flounder.—This fish (*Paralichthys dentatus*) is quite abundant on the Atlantic coast, frequenting the coast from Cape Cod to the Carolinas. It reaches a length of from 2 to 3 feet and has a weight of about 15 pounds. It is caught very extensively off the New England coast. The principal fishing grounds are in the region of Block Island, Martha's Vineyard, and the eastern end of Long Island. There is another species known as the southern flounder (*Paralichthys lethostigmus*), which flourishes from Charleston southward, and is found along the entire Gulf coast. There is also another species on the Gulf coast called the Gulf flounder (*Paralichthys albiguttus*). There is also a wide flounder or common flatfish (*Paralichthys americanus*) which is found along the coast of Labrador, southward to the Carolinas. It is especially abundant along the coast of southern New England. It is a small species, rarely being over 20 inches in length, the average length being from 12 to 15 inches, and weighs from 2 to 3 pounds. This species of flounder has been extensively propagated by the U. S. Bureau of Fisheries, as many as 100,000,000 fry having been planted in one season.

Composition of Summer Flounder.—

	Fresh.	Dry.
Water,	84.21 percent	
Protein,	13.82 "	89.03 percent
Fat,	.69 "	4.46 "
Ash,	1.28 "	8.15 "

The flesh of this fish is particularly high in water and low in fat.

Graylings.—The graylings belong to a family very closely resembling the Salmonidæ. They occur chiefly in northern or Arctic waters. One species found in Michigan is known as the Michigan grayling. It is a fish that is not only distinguished on account of its food value but also on account of its graceful shape and pleasing appearance. Another species occurs in Montana, and has been distributed very largely by the Bureau of Fisheries. It is not a fish which is of any great economic importance.

The Haddock.—This is a fish very nearly related to the cod, but it has a smaller mouth and differs in other essentials, particularly in its chemical constituents, from the cod. The haddock has a food value which is probably not inferior to that of the cod. It is one of our most abundant fishes, and by some consumers the flesh is preferred to that of the cod. The usual weight of the haddock is about 3 or 4 pounds. It is, therefore, a much smaller fish than the cod. The species is *Melanogrammus æglefinus*. On the Atlantic coast it does not occur north of the Straits of Belle Isle. The haddock is particularly abundant on the Massachusetts coast in summer. Like the cod, the haddock is well suited for salting, smoking, and curing in various ways. It, however, has not been used to such an extent as the cod for those purposes, finding a more ready market in the fresh state.

Composition.—

Water,	81.69	percent
Protein,	16.83	"
Fat,	.25	"
Ash,	1.23	"

In the dry substance.

Protein,	93.89	percent
Fat,	1.34	"
Ash,	6.76	"

The flesh of the haddock, it is seen, is even more exclusively nitrogenous than that of the cod and contains slightly less fat. The two species are often sold under the same name.

The Hake.—There are several species of hakes, family Merluccidæ. The common European hake is the species *Merluccius merluccius*. The hake which is found mostly in American waters is *Merluccius productus*, and occurs very abundantly on the Pacific coast and is largely eaten as food. The flesh, however, is rather coarse and not very palatable. Another species which is found on our Atlantic coast from New England northward is *Merluccius bilinearis*.

Halibut.—The halibut (*Hippoglossus hippoglossus*) is a fish which is highly esteemed and occurs in great quantities. It is a fish which frequents northern waters, and especially the North Atlantic on the American coast. It has not been taken south of Montauk Point, but extends as far north as the coast of Greenland, and is also found about Iceland and Spitzbergen in a latitude of 80 degrees. It does not like water above 45 degrees F., and is often found in water at the freezing point, namely, 32 degrees. The halibut is also found on the Pacific coast, especially off Oregon and Washington and in British Columbia and Alaska. It is one of the largest of food fish. The fish weighing about 80 pounds are considered the best for food, although the halibut sometimes reaches a weight of over 500 pounds. The male is always smaller than the female and less palatable. The annual value of the halibut fisheries on the North Atlantic coast is probably ¾ million dollars. It is probably slightly more than this on the Pacific coast,—in fact the Pacific coast fisheries have grown so extensively that halibut is shipped eastward across the continent. Vast freight trains known as the "Halibut Express" have been sent across the continent from Vancouver to Boston, making the trip in six or seven days.

Composition.—

	Fresh.	Dry.
Water,	75.42 percent	
Protein,	18.35 "	77.18 percent
Fat,	5.17 "	19.32 "
Ash,	1.06 "	4.39 "

The halibut is a fish containing considerable quantities of fat, and is not so peculiarly nitrogenous in its character as the cod or the haddock. It, therefore, makes a better balanced ration than either of the other fish. The halibut in the fresh state is esteemed fully as highly as the cod, and the halibut steak is a very common part of the fish sold upon the market.

Herring.—The herrings form a very important group of fishes belonging to the family Clupeidæ. There are about 30 genera in the family and 150 species. The herrings are essentially salt-water fishes and are usually found in large schools. Many species, and some of these the most valuable for food, ascend fresh-water streams for spawning. Certain species, for instance, are caught at the same season as the shad in the Chesapeake and Susquehanna. There are a few species which remain permanently in fresh water. The common herring (*Clupea harengus*) is one of the most important of the food fishes of the whole Atlantic coast, and really over almost all the north Atlantic, throughout which it is generally distributed. The principal herring fisheries are in the North Sea, in Denmark and Norway. Important fisheries are also found off the coast of Great Britain, Belgium, France, and the United States. It is estimated that as many as three billion herring may be found in a shoal covering a dozen square miles. Herring shoals of much larger extent are on record. The herring do not frequent southern waters, but are found in the cool and more northern waters of the Atlantic. On the coast of the United States it has been found as far south as Cape Hatteras, though it does not occur very abundantly further south than New England. The fish at the period of spawning are considered the most valuable for food purposes.

The herring is either sold in a fresh state or it may be smoked, salted, or pickled, and in this condition is very extensively used as food. A species of herring is found on the Pacific coast known as California herring (*Clupea pallasii*). It does not differ very greatly in its general aspect from its relation on the Atlantic coast. This species occurs very abundantly in the region of Puget Sound, especially in summer time, and in southeast Alaska. They are extremely abundant in San Francisco markets in the spring time, so much so that it is difficult to find a sale for them.

The California herring are more highly valued and bring the highest price in the early winter, when they are the fattest.

Composition of Herring.—

	Fresh.	Dry.
Water,	69.03 percent	
Protein,	18.46 "	61.69 percent
Fat,	11.01 "	35.55 "
Ash,	1.50 "	4.83 "

The above data show that the flesh of herring is particularly rich in fat. In fact the herring is sometimes used as a source of oil. In southeast Alaska are extensive oil and guano works which utilize the herring for these purposes.

Horse Mackerel.—Another species belonging to the mackerel family is the horse mackerel or tuna (*Thunnus thynnus*), which is found in considerable abundance on our North Atlantic coast and on the coast of southern California. Its common name is "tuna," "tunny," "horse mackerel," or "great albacore." The horse mackerel is a fish of very great size and is the very largest of the whole mackerel family. They occasionally attain a length of 10 feet or more and a weight of 1500 pounds. The average dimensions, of course, are very much less than this. The horse mackerel does not grow so large in Europe or upon the Pacific coast. In these regions a horse mackerel weighing 500 pounds is considered of an extraordinary size. The very large ones are never taken with hook and line, but there are records of fish of over 200 pounds that have been captured in this way.

The Hogfish.—The hogfish of the West Indies and our southern coasts is another of the wrasse-fishes whose scientific name is *Lachnolaimus maximus*. It is called in Porto Rico "el capitan." It often reaches a weight of 20 pounds and a length of from 2 to 3 feet. The name "hogfish" doubtless is derived from the shape of the head, which resembles somewhat that of the hog. It is valued as a food fish throughout the West Indies.

Lake Herring.—The so-called lake herring is very closely related to the whitefish. The name of the species is *Argyrosomus artedi*. The lake herring has a large number of common names, of which the most widely applied is the term "Cisco." The terms blueback, greenback, and grayback are also applied to these herring. The habitat of this fish is that of the whole region of the Great Lakes and north to Hudson Bay. It has much the same habitat as the whitefish. The average weight of the lake herring is about one pound. The subspecies (*Argyrosomus artedi sisco*) is found in Lake Tippecanoe and other small lakes in Wisconsin and northern Indiana.

Composition of Cisco.—

	Fresh.	Dry.
Water,	76.15 percent	
Protein,	19.12 "	80.75 percent
Fat,	3.48 "	14.59 "
Ash,	1.25 "	5.25 "

Mackerel.—The mackerel is a food fish which is very commonly used in a cured state in the interior of the country and is eaten fresh on the sea coast. Its habitat is principally the North Atlantic ocean. On the coast of the United States it is found from Cape Hatteras north to the Strait of Belle Isle. In Europe it is found from Norway southward to the Mediterranean and Adriatic. The mackerel on the Atlantic coast usually appear first in the spring near Cape Hatteras and following the custom of the shad are found later farther north in the New England states and also in the British possessions. They leave the coast in the inverse order in the autumn, disappearing first in the northern regions and later in the southern portion.

The mackerel is one of the most abundant of fishes in the Atlantic Ocean, traveling in immense schools. There is record of a school which was seen in 1848 which was at least half a mile wide and 20 miles long. In some seasons the mackerel is extremely abundant and in others very scarce. The average catch is probably about 300,000 barrels. Boston and Gloucester are centers of the mackerel fishing industry. It is estimated that from 150 to 300 vessels of American bottoms are engaged in the mackerel industry. The U. S. Bureau of Fisheries has been particularly interested in the propagation of mackerel, but the result has not been as satisfactory as in the case of many other fishes. The young mackerel or small fishes are known as "spikes," "blinkers," and "tinkers." When they are about two years old they measure from 5 to 9 inches in length. The mackerel attains its full size at about the fourth year. The scientific name of the common mackerel is *Scomber scombrus* Linnæus.

Composition of Mackerel.—Edible portion:

	Fresh.	Dry
Water,	73.37 percent	
Protein,	18.26 "	71.71 percent
Fat,	7.09 "	24.88 "
Ash,	1.28 "	4.78 "

The above data show that the flesh of the mackerel is composed of about two-thirds protein and one-third fat and ash.

Pickled mackerel, salted mackerel, and smoked mackerel are perhaps as highly valued for food purposes as the fresh fish itself.

Menhaden.—The menhaden is not used chiefly as a food fish but to some extent therefor. It is one of the most abundant fishes taken upon our Atlantic coast and is used almost exclusively as a source of oil, the residue being dried and ground for fertilizing purposes. In this sense it has great value because of the high nitrogen content of the residue and also of the considerable quantity of phosphoric acid which is contained therein.

The menhaden is known scientifically as *Brevoortia tyrannus.* Up to 1880 immense quantities of menhaden were taken off the Atlantic coast. Since that time the supply has not been considered so great. In the year 1877 it is stated by Jordan and Evermann that one oil company took 20 million fish and in one town alone, namely Booth Bay, 50 million fish were caught.

The fecundity of the menhaden is very great, exceeding that of the shad. More than 140,000 eggs have been taken from a single fish. The menhaden are not eaten very extensively in a fresh state as food but preserved in salt they have a considerable value for that purpose. An extract has also been made from the flesh of the menhaden on the same principle of manufacture as is utilized in preparation of meat extracts. The menhaden is known under a great number of common names, some thirty of which have been enumerated by Dr. Goode.

Composition of Menhaden.—

Water,	77.15	percent
Fat,	3.91	"
Protein by difference,	18.94	"

The water-free flesh contains (including bones) 21.7 percent of mineral matter.

Composition of the Mineral Matter.—

Lime,	8.67	percent
Phosphoric acid,	7.78	"
Silicic acid,	1.33	"
Potash,	1.54	"
Soda,	1.02	"
Magnesia,	0.67	"
Chlorin,	0.69	"
Total,	21.70	"

Mullet.—The mullet belongs to the Mugilidæ, an important family of fishes in which there are several genera and species. The mullet is not particular about its food but is in the habit of swallowing large quantities of mud, or rather partially swallowing it and separating the refuse and most obnoxious particles by means of the gills. The common mullet or striped mullet (*Mugil cephalus*) is a widely distributed species. This fish is common along the Atlantic coast and in Hawaii, usually traveling in large schools, and is most abundant in the shallow waters of the coast. It sometimes reaches a length of two feet and is an important food fish. The mullet is very abundant on the Florida coasts. While the mullet may be regarded as a scavenger, living principally on mud, it does not eat any other species of fish, but is itself eaten by nearly all fishes that can gain access to it.

Composition of the Mullet.—

	FRESH.	DRY.
Water,	74.87 percent	
Protein,	19.32 "	77.50 percent
Fat,	4.64 "	18.45 "
Ash,	1.17 "	4.66 "

Muskallunge.—A very noted member of this family is the muskallunge (*Esox masquinongy*). It is a native of the Great Lakes and is especially found in the upper St. Lawrence. It is not a very abundant fish, but is highly prized from the angler's point of view. It is of very great size, having been found as long as 8 feet and weighing over 100 pounds. Two other species of muskallunge are known, one (*Esox ohiensis* or the Chautauqua muskallunge) in the Ohio river basin, particularly in Lake Chautauqua, where it has been artificially propagated with great success, and the unspotted muskallunge (*Esox immaculatus*), which occurs sparingly in certain small lakes of northern Wisconsin and Minnesota.

Composition of the Muskallunge.—

	FRESH.	DRY.
Water,	76.26 percent	
Protein,	19.63 "	84.87 percent
Fat,	2.54 "	10.70 "
Ash,	1.57 "	6.63 "

The flesh of the muskallunge, as is seen, contains about four times as much fat as that of the pickerel, and forms a ration which is not so unbalanced as that of the pickerel itself.

Pickerel or Pike.—One species (*Esox reticulatus*) is of common occurrence along the Atlantic coast and also in the fresh-water streams of the southern interior portions of the country. The pike of the Great Lakes belongs to the species *Esox lucius* Linnæus. It is found in the fresh waters of North America, Europe, and Asia, but is not found on the Pacific coast except in Alaska. It reaches in some cases a large size, having been found as much as 4 feet in length and weighing 40 to 50 pounds. The Kankakee in northern Indiana is a well-known fishing ground for this species of pike.

Composition of Pickerel.—Edible portion:

	FRESH.	DRY.
Water,	79.68 percent	
Protein,	18.64 "	92.15 percent
Fat,	.50 "	2.48 "
Ash,	1.18 "	5.80 "

The flesh of the pickerel, as is seen, is almost a pure type of protein. The fat falls to an insignificant quantity, being only about half as much as the ash.

Wall-eyed Pike.—The wall-eyed pike or pike perch (*Stizostedion vitreum*) is a fish most abundant in Lake Champlain, the Great Lakes, and in eastern Canadian lakes; it occurs also in certain small lakes and streams in the upper Mississippi valley. In some localities it is known as the salmon or jack salmon, but of course these are misnomers.

Composition.—

	Fresh.	Dry.
Water,	75.71 percent	
Protein,	19.03 "	79.31 percent
Fat,	4.07 "	16.74 "
Ash,	1.19 "	4.92 "

Common Pompano.—The pompano (family Carangidæ) is one of the food fishes which is most highly esteemed along the Gulf coast. It has been found as far north as Cape Cod on the Atlantic coast, but does not occur in sufficient numbers to make it of any economic value as a food fish north of Florida. It is taken chiefly in the Gulf waters. The average weight of the pompano is from 2 to 3 pounds, though very much larger examples are sometimes found. As a food fish there is none that is regarded more highly than the pompano, especially when it is eaten fresh from the water and prepared in the manner of the creole cooks of New Orleans.

Composition.—

	Fresh.	Dry.
Water,	72.78 percent	
Protein,	18.65 "	72.37 percent
Fat,	7.57 "	24.46 "
Ash,	1.00 "	3.82 "

These data show that the edible portion of the pompano is valued both for its protein and its fat. The latter exists in quantities of approximately one-third of the former. It is not so much its nutritive value which makes the pompano desirable as a food fish but the extreme delicacy of flavor and the richness of its taste. It does not bear shipping well, and therefore is found in its greatest perfection only near the place where it is taken.

In New Orleans and in Florida the pompano is one of the principal food fishes furnished by the high-class hotels and restaurants to their guests.

Red Snapper.—The red snapper (*Lutianus aya*) is the most noted fish of all the snapper family (Lutianidæ), although there are others which are highly prized, such as the gray snapper. It sometimes reaches a length of two or three feet and a weight of from 10 to 35 pounds. It is particularly abundant in the deep waters of the Gulf of Mexico and off the west coast of Florida. The red snapper bears shipping better than most of the Gulf fish, and Pensacola is one of the principal points where the fish are packed in ice as soon as possible after capture and dispatched to northern markets.

Composition.—

	Fresh.	Dry.
Water,	78.46 percent	
Protein,	19.20 "	91.75 percent
Fat,	1.03 "	4.70 "
Ash,	1.31 "	6.05 "

This is another one of the fishes in which the edible portion is almost exclusively protein, the fat appearing only in small quantities.

Rock Bass; Redeye; Goggle-eye (*Ambloplites rupestris*).—The rock bass is a very common fish particularly abundant in the fresh waters of the northern central portions of the United States. It is the fish which the American boy, living near small streams, most delights to catch. The size of the rock bass varies largely according to the magnitude of the body of water in which it lives. The average weight of the fish in streams of ordinary size is probably about a pound, though often it is considerably more. The rock bass has been propagated to some extent by the Bureau of Fisheries and has been introduced into waters where it formerly did not occur.

Salmon.—The salmon is one of the most important food fishes of the United States. It belongs to the genus *Orcorhynchus*. The five species of this genus are, in America, confined to our Pacific coast. Of these species the one known as blueback or sockeye is found most abundantly in the Fraser and Columbia rivers and in Alaska, the silver salmon in Puget Sound, the chinook salmon in the Columbia, and the dog salmon along the coast from California to Bering Sea. The salmon begin running early in the spring and the early run is considered of greater value than the later. The habits of the salmon in the deep waters of the ocean are not very well known. It is only when they come into fresh water for spawning purposes that their life history can be well studied. It is believed, however, that they do not go very far from the shore. The run of salmon on the Pacific coast usually begins about the latter part of March and lasts through the spring and greater part of the summer. On account of the great abundance of these fish on the Pacific coast and the distance from large markets the canning industry has developed with great rapidity. In fact on the Pacifie coast the product of salmon fishing is devoted almost exclusively to canning purposes. In the canning of salmon no particular care is taken, and perhaps none at all to designate upon the can whether its contents are of the early salmon or the later, less valuable run. It is claimed by many authorities that the salmon of the Pacific coast of America, taken all together in their relation to the economic problem of fish food, are the most important and valuable fish in the world.

Composition of a Pacific Coast Species.—

	Fresh.	Dry.
Water,	63.61 percent	
Protein,	17.46 "	52.31 percent
Fat,	17.87 "	49.05 "
Ash,	1.06 "	2.92 "

Composition of Atlantic Salmon.—

	Fresh.	Dry.
Water,	63.61 percent	
Protein,	21.60 "	61.45 percent
Fat,	13.38 "	36.88 "
Ash,	1.41 "	3.81 "

The above data show that the Pacific salmon are richer in fat than the Atlantic salmon. In fact in the edible portion of the fish the fat is almost as great as the protein.

Another species of Pacific salmon is the humpback salmon (*Oncorhynchus gorbuscha*), which appears in great abundance in the rivers of Alaska, but not every year,—usually coming in larger quantities in alternating years. As a fish to be eaten fresh, this is one of the very best of the salmons. Owing to the pale color of the flesh, this species does not hold as high a rank for canning purposes. It cans well, however, and the product is very palatable and doubtless very nutritious. The trade-name of the canned product is "pink salmon," as its flesh is of a paler color than that of the chinook salmon or red salmon. Another species is known as dog salmon. It is found in considerable abundance from California northward to Bering Strait, spawning usually late in the fall. It is considered as the least valuable for food purposes, although it is now coming to be used very extensively by freezing, in which form it finds a ready market both in this country and abroad. When canned it is put on the market as "chum." Its chief interest at the present time is on account of the fact that it is sometimes sold under the names of better species.

Chinook Salmon (*Oncorhynchus tschawytscha*).—This species is also known as quinnat, king, Columbia river, and Sacramento river salmon. It is, next to the sockeye, the most important of all salmon in commercial value. The individuals of this species reach a larger size than those of any other. They have been known to weigh 90 pounds, and fish of from 40 to 60 pounds in weight are not infrequently taken. The average weight of the king salmon which are captured in the Columbia river is probably not far from 22 pounds, while those that run further south, for instance in the Sacramento river, average 16 pounds.

Another species, known as silver salmon (*Oncorhynchus kisutch*), also has a number of other names, mostly of Eastern or Russian origin. It is quite an important member of the genus and its average weight is about 5 pounds. It is very valuable as a food fish, only the Chinook and blueback salmon going ahead of it. It is also a species which bears shipment in a fresh state very well. The silver salmon resembles very closely the Chinook, but is easily distinguished therefrom by experienced fishermen. The canned product of this species is usually put on the market as "medium red" or "coho" salmon, names which have now come to have a definite meaning and are perfectly understood by the trade.

The Sockeye or Blueback Salmon (*Oncorhynchus nerka*).—This is the species which has the greatest commercial value and forms a large part of the catch of the Pacific coast. It is the most abundant of all the species of salmon in Alaska. Its flesh has a rich red or "salmon" color, and lends itself admirably to canning processes. In palatability and attractiveness as a canned product it is not inferior to any, unless, possibly, it is the Columbia river chinook.

Canning of Salmon.—The canning of salmon is one of the most important of the fish industries of the United States. The immense coast line possessed by the United States on the west, which is so vastly extended by the Alaskan coast and Aleutian Islands, affords the most extensive fisheries of salmon in the world. As has already been stated, there are no large markets in that region in which the fresh salmon can find a purchaser. The fish, therefore, must be neglected as a food product or else prepared in some way to enable them to be shipped to great distances. Probably the most unobjectionable way is by canning. The principles of the canning of salmon are not different at all from those which underlie the sterilization of any kind of food. The establishments in which the canning takes place are perhaps the most extensive in the world. The prime necessity in these cases is to secure complete sterilization. In the case of fish any failure to secure the proper sterilization is the more reprehensible, because fish decompose so readily, forming fermentative products which are extremely poisonous. Cases of poisoning from eating canned salmon have been reported, and in some cases they may prove fatal. Every can of salmon which is to be eaten ought to be examined carefully in order to see if there are any incipient signs of decomposition. A bad smelling or otherwise imperfect can should be rejected without question. Only the fish which is perfectly fresh to the taste and odor and which gives no signs of any kind of deterioration should be eaten. When properly prepared, canned salmon affords a delicacy as well as a food product which can hardly be too highly prized.

Composition of Canned Salmon.—Mean of three samples. Water-free substance:

Protein,	53.52	percent
Fat,	40.52	"
Ash,	6.24	"

The Salmon of the Atlantic Coast.—As has already been noted, the Pacific salmon belong to a different genus from the common Atlantic salmon,—*Salmo salar.* There is a very close resemblance between the two genera, and the common name "salmon" is applied to the individuals of each. The Atlantic salmon is a fish which has been known from the earliest time. The Roman people became acquainted with it in the early history of the Republic, and especially when they conquered Gaul and Britain. It is found distributed over the whole North Atlantic coast, but especially the northern portion from Massachusetts northward. The salmon extends, as far as observations have been made, beyond even the Arctic circle, and the same species is found upon the western and northern shores of Europe. The salmon enters the St. Lawrence and has been found as far up as Niagara Falls. Our principal fisheries for this species are in Maine and in Canada, Nova Scotia, and New Brunswick. They do not extend southward beyond the Delaware and have rarely been found in that river. The shad and salmon were particularly abundant in early colonial days. The shad were so abundant that they were not regarded as useful for food purposes, but their value as a fertilizer was taught to the whites by the Indians. Salmon, apparently, were equally abundant, and it was considered an affront to offer salmon more than twice a week even to servants. In this respect they were on the same plane as the diamond back terrapin and canvas back duck, which were so abundant, in those days, that they were a drug on the market. The salmon enters the fresh-water streams for the purpose of spawning. The eggs are largely laid late in the fall, and in that case do not hatch until the next spring. The Atlantic salmon often reach a very large size. Individuals have been known to weigh from 40 to even 80 pounds. The average weight of the salmon taken in Maine waters is about 10 pounds each. Another valued specimen of salmon is known as the Sebago salmon (*Salmo sebago*), from the lake in which it occurs. It is a fresh-water fish, having been doubtless landlocked in some way after originally entering from the sea. Still a third species is the famous ouananiche (*Salmo ouananiche*), inhabiting the waters of the Lake St. John region north of Quebec.

Composition of Atlantic Salmon.—

	Fresh.	Dry.
Water,	76.74 percent	
Protein,	18.52 "	79.13 percent
Fat,	3.60 "	15.32 "
Ash,	1.14 "	4.93 "

Composition of Sebago Salmon.—

	Fresh.	Dry.
Water,	78.54 percent	
Protein,	17.24 "	78.00 percent
Fat,	2.98 "	13.74 "
Ash,	1.24 "	5.76 "

The above data show a striking difference in the composition of the edible portions of Pacific and Atlantic salmon. This difference is shown chiefly in the relative proportion of fat. In the Pacific salmon the fat approaches in quantity the protein, while in the Atlantic salmon the protein is much greater than the fat. The Atlantic salmon is used chiefly in the fresh state for two reasons, first, because the catch is very much smaller than that of the Pacific species while the markets are very much more numerous and very much larger; second, because it is commercially more profitable to dealers in the fresh state. In Europe and Scotland the salmon is constantly used in a fresh state during the whole of the summer and a dinner is scarcely considered complete without it. It is also very commonly used at luncheon. It is generally eaten cold and offers a food product of high palatability and great nutritive value in so far as the protein is concerned. Eaten with plenty of potato, as it usually is, it forms a reasonably well-balanced ration. The American visitor who is not used to eating salmon every day is likely to find its constant occurrence upon the English table in the summer to be a bit trying to his taste.

Sardines.—The sardine and herring belong to the same family—in fact, small herring along the coast of Maine are put up as sardines. The sardines are very closely related to the herrings, but there are rather important differences. The European species, which is known as the sardine, is the *Sardinia pilcharda*, and does not occur on the coast of the United States. The species existing on the Pacific coast is known as the California sardine (*Sardinia cærulea*). It is quite abundant on the California coast and spawns in the open sea. It resembles very strongly the European sardine, but has no teeth. The Spanish sardine (*Sardinia pseudohispanica*) is found rather abundantly in Cuba and is often carried northward in the Gulf Stream as far as Woods Hole or Cape Cod. It is about 8 inches in length and of high food value, resembling very closely the European sardine. There has been a good deal of discussion as to whether or not small herring which are packed as sardines in the United States should be allowed, under the food laws of the various states and of the United States, to be sold by that name. The answer to this is that any deception in the label should be avoided. The preservation and packing of different fish in the same way gives no right to a common name. The true ethical principles of trade require that some qualification of the name be secured, in order to protect the name sardines, which is reserved exclusively for the species *Sardinia pilcharda.*

Composition of Canned Sardines.—

Water,	56.37	percent
Water-free substance,	43.63	"
Protein,	24.87	"
Fats,	12.71	"
Ash,	5.00	"
Sodium chlorid,	0.61	"

The above data are based upon the analysis of the sample after the oil has been separated by drainage.

European Sardines.—The sardine is eaten fresh along the Spanish and French coast, where they are taken in great abundance and form a delicious food in this condition. The number which is given to a single individual is quite generous, as the writer has had served him on the Mediterranean coast in Spain as many as twenty fresh sardines at one order. The number, however, was not found any too large when the palatability of the product was taken into consideration. Sardines are preserved by salt and smoke and particularly by packing in oil.

Method of Packing in Oil.—The sardines after proper cleaning are heated in oil for the purpose of sterilizing them. Olive oil is usually employed for this purpose, though some packers prefer to heat the fish in peanut oil, claiming that it gives them a better color. There seems to be, however, no sufficient ground for this claim. The peanut oil is probably used simply because it is cheaper. When the fish are thus sterilized and thoroughly cooked they are placed in boxes in the well known manner in which they are found and covered with oil, sealed, and, if necessary, again sterilized in order to prevent decomposition. Olive oil is the oil usually employed for packing purposes, though cheaper grades of edible oil are very commonly found in sardines. The substitutes for olive oils which are usually employed are peanut oil, cottonseed oil, and sesame oil, either single or mixed. When the sardines have been previously boiled in a cheaper oil and then packed with olive oil the olive oil will be contaminated with the cheaper oil used in the boiling.

Adulteration of Sardines.—As indicated above, the chief adulteration of sardines is in the misbranding respecting the nature of the fish and the oil used in packing. A young herring packed in the manner of a sardine properly demands a special label instead of the word "sardine" alone. A difference respecting the misbranding in regard to the oil employed is avoided by the statement on the package of the character of the oil used. The phrase "Sardines packed in oil" should be construed always to mean in the highest grade oil, that is, olive oil. This phrase, however, is usually employed when inferior oils are used. Inasmuch as oil is not the name of any individual product but of a large class of products, including that of both animal and vegetable origin, it is generally held that the term "oil" is not a sufficient indication of the character of the oil used. In all cases the packages should designate the special kind of oil used in the preparation. The addition of chemical preservatives to sardines in so far as the author knows, is not practiced, at least not to any appreciable extent.

The French Fisheries.—The sardine fisheries in France are mostly off the coast of Brittany, and are subject to many very serious fluctuations. For instance, the present year, 1906, has been one of disaster to the French fisheries. What is the cause of the disappearance of the pilchard (the true sardine) is not known. The fishermen think that large fish have driven the small ones either into the Bay of Biscay or the Mediterranean, or even to the west shores of Africa. The fish are thought to originate in the Mediterranean, and their name is derived from the fact that they were originally found in great quantities off the coast of Sardinia. When the spring comes and the fine weather is established they migrate first along the coast of Spain, finally reaching the French coast some time during the month of May. By this time the young fish are nearly grown to a proper size for catching. The fishing, however, does not really begin until July and is usually finished by November. The little town of Concarneau is the seat of these fisheries. About two thousand small boats go out from this town and at or near this place are also the large canneries and packing establishments. The fishing grounds are about five miles from the coast and the small boats sail out from two to four o'clock in the morning. The fishing is by means of nets and a very important part of the work is the spreading of the bait upon the surface of the water to attract the fish. The principal bait or *roque* is the roe of the cod, which sometimes reaches a price of $60 per barrel. Sometimes a single boat will use from 30 to 40 barrels of bait. Only the most skilled fisherman, usually the master himself, is allowed to distribute this precious material. As many as one hundred thousand fish have been caught in the net, though this magnitude of catch is, of course, exceptional. When the fish are brought ashore they are counted into baskets, about 200 to a basket, and those unfit for use are thrown out. They are taken to the canneries as quickly as possible to be cleaned, boiled, dipped in oil, and then hermetically sealed in a tin in which they are sent into commerce.

Adulteration.—The chief adulteration of sardines is found in misbranding as to country of origin. The French catch has the highest reputation of any in the world and for this reason the label is often made to represent the fish as of French origin when in reality they are caught on the shores of Spain or of other countries. Formerly the fish were brought in great numbers from the Spanish coast into France. They were naturally much deteriorated in transit. Nevertheless they were tinned and marked as of pure French origin. This practice has now been forbidden by law in France. The Norwegian fish known as Sprötten (sprats) on the German and Holland coasts are packed as sardines and sent into this country as sardines.

Scup.—The scup is a fish (family Sparidæ) which is taken in great abundance on our Atlantic coast in the summer and autumn and is brought in immense quantities to the market. The proper name of the fish is *Stenotomus chrysops*.

Composition.—

	Fresh.	Dry.
Water,	74.99 percent	
Protein,	18.52 "	75.33 percent
Fat,	5.11 "	19.25 "
Ash,	1.38 "	5.64 "

The flesh of this fish is a better balanced ration than that of the red snapper, the proportion of fat being much larger.

Shad.—One of the most important food fishes on the Atlantic coast is the shad. It is found along the whole Atlantic coast, coming into fresh water for spawning, where it is caught for food purposes. The shad begin to appear in the streams of the south Atlantic coast early in the winter and as the spring advances they go northward. They appear in the Potomac in April and May, and later in the Delaware and Connecticut rivers and other fresh-water streams further north. The fish is, therefore, to be had fresh upon the market over a long period of time. The common shad is known scientifically as *Alosa sapidissima* (Wilson). As a result of the work of the U. S. Bureau of Fisheries the shad has been introduced into the waters of the Pacific coast where none was found originally. The shad fry were first introduced into the Sacramento river and afterward into the Columbia river. The environments on the Pacific coast were found congenial. The fish soon found grounds on which they could spawn, and they have spread over almost the entire length of the Pacific coast. It has, of late, become a very common and abundant food fish on the Pacific coast and has lost none of its palatability by transplanting. Science has not been able to ascertain anything of very great interest respecting the life of the shad in the sea. When they leave the rivers they practically disappear, and are not known again until the next spawning season returns. For spawning purposes the shad prefer a water temperature of from 55 to 65 degrees. Whenever the temperature goes above the latter figure they begin to disappear. The males and females go in separate schools. The males usually precede the females. It is stated by Jordan and Evermann that of 61,000 shad received at the Washington market from March 19 to 24, 99 percent were male. As the season advanced the males became very much less frequent and at the end extremely scarce. The U. S. Bureau of Fisheries has taken especial pains to increase the number of shad in all waters. During the spring of 1900 there were artificially planted in the Atlantic coast streams over 240,000,000 young shad. One fish often contains as many as 150,000 eggs. The average number, however, is about 30,000. Shad roe is the most valuable part of the fish and brings a much higher price in the market than an equal weight of fish itself. Planked shad is one of the greatest delicacies of the Washington markets. At Marshall Hall, opposite Mount Vernon, there are given a great many shad bakes during the season. Oak wood is placed in long lines and burned,—oak planks are set up on each side of the line of burning wood, inclined at an angle of about 60 or 70 degrees. On these oak planks the shad are cooked, held usually by driving a nail through the head,—the cut surface being exposed to the heat of the burning fire. In addition to being cooked in this way the fish absorbs a small amount of the empyreumatic odors of the burning wood. During the baking the shad are treated from time to time with melted butter. There is no other way which a shad can be cooked which renders it so delicious as by this primitive method. The shad, from an economic point of view, is third in importance in the United States, only the salmon and the cod exceeding it in value. The annual catch of shad on the Atlantic sea coast numbers from 10 to 20 million, weighing from 40 to 60 million pounds and worth from one and one-half to two million dollars.

Composition of Shad.—

	Fresh.	Dry.
Water,	70.62 percent	
Protein,	18.56 "	64.36 percent
Fat,	9.47 "	31.93 "
Ash,	1.35 "	4.62 "

Of the whole weight of shad the average edible portion amounts to 52.35 percent, and the refuse, counting the bones, skin, and entrails is 47.65 percent.

Shad Roe.—The eggs of shad, as has already been mentioned, are regarded as the most valuable portion of the fish. Roe shad also are more highly prized as a food fish than the male shad. As a result, roe shad sell for a much higher price on the market than the male shad. The eggs are quite small, and as has already been said, occur in immense numbers, the average number to a fish being about 30,000.

Composition of Shad Roe.—

Water,	71.2 percent
Protein,	23.4 "
Fat,	3.8 "
Ash,	1.6 "

Aside from the water of the roe, it is noticed that by far the most abundant component is the protein. This, of course, is what would be expected of an egg product. The protein is a little more than six times as great as the fat. The ash contains large quantities of phosphorus, which exists in the original egg, largely in the form of lecithin, in which state it is regarded as most valuable for nourishing the phosphatic tissues of the body. Shad roe is eaten almost entirely in the fresh state. It does not produce a pickled or cooked product of anything like the value of the sturgeon eggs. So far as the author knows no form of shad egg preparation similar to caviar is on the market.

There are three species of shad in America, but the only one of great importance is the common Atlantic shad which has been described.

The Sheepshead.—This abundant and important food fish exists in large numbers along the Atlantic coast. It also belongs to the Sparidæ and its scientific name is *Archosargus probatocephalus*. This species is found from Cape Cod to Texas. It is especially found in the vicinity of oyster beds, where it is destructive to the oysters. It is quite abundant in the Indian river, being, next to the mullet, the most frequently found fish in those waters. Though strictly a salt-water fish, it often runs up into fresh waters. The fish is distinguished by the number of broad silvery colored bands extending around its entire body. The average weight of the sheepshead is three or four pounds, though occasionally a fish three or four times that size is captured.

Composition of Sheepshead.—

	Fresh.	Dry.
Water,	75.55 percent	
Protein,	19.54 "	83.47 percent
Fat,	3.69 "	13.59 "
Ash,	1.22 "	5.14 "

The Smelt.—The smelt belongs to a family which has a number of species, some of which are very abundant in Europe, where they are highly prized even to a greater extent than in this country for food. The smelt is a small fish, very long in proportion to its breadth. The American smelt (*Osmerus mordax*) is found very abundantly on the Atlantic coast north of New York. Although a sea fish, it often enters rivers and becomes landlocked in lakes. It is found abundantly in Lakes Champlain and Memphremagog and many of the New England and Nova Scotian lakes. The smelt in early times was a very abundant fish.

Composition of the Smelt.—Edible portion:

	Fresh.	Dry.
Water,	79.16 percent	
Protein,	17.37 "	84.31 percent
Fat,	1.79 "	8.65 "
Ash,	1.68 "	8.16 "

These data show that the flesh of the smelt is very rich in protein, the fat falling to a very small proportion of the total edible substance.

Spanish Mackerel.—This is a very highly prized fish and is eaten largely in the fresh state along the Atlantic coast. Its scientific name is *Scomberomorus maculatus*. The catch is subject to great variations. In early years the Spanish mackerel was scarcely known on our coast, but in the last forty years it has assumed considerable importance. Although more abundant than formerly it still commands a very high price. The weight of the full-grown mackerel is usually from five to eight pounds, though occasionally very large individuals are taken. Jordan and Evermann speak of one which was 41 inches long and weighed 25 pounds.

Composition.—Edible portion:

	Fresh.	Dry.
Water,	68.10 percent	
Protein,	20.97 "	67.25 percent
Fat,	9.43 "	29.56 "
Ash,	1.50 "	4.71 "

In this fish it is seen that the fat is a little less than one-third the quantity of the protein.

Sturgeon.—The sturgeon belongs to the family of Acipenseridæ. They are large fishes frequenting the sea and also the fresh waters of northern regions. Most of the species are anadromous, entering fresh water and ascending the streams in spring. There are two genera belonging to this family and 20 species that are well defined, although about 100 nominal species have been described. The white sturgeon or Oregon sturgeon is found on the Pacific coast from Monterey north to Alaska. It ascends the large rivers during the spring, notably the Sacramento, Columbia, and Fraser rivers. Some of them are very large and their value for food and commercial purposes has only been lately recognized. They are principally valuable, however, for their eggs or roe, since it is from the eggs of sturgeon that caviar is made. The roe in the fresh state is worth from 25 to 30 cents a pound. The fresh fish are frozen and shipped to Eastern markets.

The common sturgeon (*Acipenser sturio*) frequents the east and north Atlantic coast and ascends the rivers in the spring, especially the Delaware. The quantity of sturgeon taken, however, has constantly decreased for several years. The principal part of the caviar made in the United States is procured from the common sturgeon and the Lake sturgeon, which is found in the Great Lakes, the upper Mississippi Valley, and the Lake of the Woods.

Preparation of Caviar.—After the eggs have been removed from the fish, they are placed in large masses upon a stand, the top of which is formed of a small-meshed screen. On the under side is placed a zinc-lined trough, about 18 inches deep, 2 feet wide and 4 feet long. The operator gently rubs the mass of eggs back and forth over the screen, whose mesh is just large enough to let the eggs drop through as they are separated from the enveloping membrane. They thus fall into the trough from which they are drawn off into tubs through a sliding door in one end of the trough. After all the roe has been separated, the tub is removed and a certain proportion of the best Luneberg salt is added and mixed with the eggs by careful stirring with the hands. This is the most delicate part of the whole process, and the best results can be obtained by that proficiency which comes from long experience. After adding the salt, the eggs at first become dry, but in 10 or 15 minutes the salt has drawn from the eggs their watery constituents and a copious brine is formed, which is poured off when the tub becomes too full. The salted eggs are then poured into fine-meshed sieves which hold about 10 pounds each, where they are allowed to drain for 8 to 20 hours. The eggs have now become the caviar of commerce, which is put in casks or cans of various sizes.

Composition of the Flesh of Sturgeon.—

	Fresh.	Dry.
Water	78.71 percent	
Protein	17.96 "	85.19 percent
Fat	1.90 "	8.90 "
Ash	1.43 "	6.72 "

Composition of Caviar.—

Water	66.05 percent
Protein	14.37 "
Fat	8.97 "
Ash	7.26 "
Undetermined	3.35 "

Of the ash, 6.16 parts of the 7.26 present are common salt.

Composition of the Eggs of Fish.—Attention has been called to the valuable food properties of the eggs of fishes. The roe of a number of fishes is celebrated both for flavor and food value. The two most important roes are those of the sturgeon, used in the manufacture of caviar, and the roe of shad, used principally in the fresh state.

Composition of Roe.—The composition of shad roe, fresh sturgeon caviar, and pickled caviar is given in the following table:

	Water.	Protein.	Fat.	Ash.
	Percent	*Percent*	*Percent*	*Percent*
Shad roe,	71.25	23.44	3.78	1.53
Fresh caviar,	56.97	27.87	2.85	2.31
Pickled caviar,	50.92	27.92	13.59	7.57

The above data show a marked difference between the composition of shad roe and sturgeon roe, the latter being very much richer in fat and also containing a greater quantity of ash. The large quantity of ash in the pickled caviar is doubtless due to the common salt used in the curing. There is not a very great difference between the composition of the roe and that of the flesh of fish. The roe is essentially a nitrogenous food, also with a considerable quantity of fat and with a certain amount of mineral matter. It contains less water than the flesh of fish, and, therefore, pound for pound in the fresh state has a larger quantity of nutrients. Otherwise, for food purposes, there is but little difference. It is doubtless true, however, that the mineral matters of the roe are somewhat different from those of the flesh of fish in containing a larger quantity of organic phosphorus in the form of lecithin.

Striped Bass.—The striped bass or rock (*Roccus lineatus*) is a fish of the family Serranidæ and quite common in the Potomac. It occurs commonly around the Atlantic coast. Its scientific name is *Roccus lineatus*. It is taken in all waters along the coast from the Carolinas to New England, and especially near the mouth of the Potomac and in Chesapeake Bay. It is a fairly common as well as one of the best food fishes at Washington and in many of the fish markets on the Atlantic coast.

	Fresh.	Dry.
Water,	77.70 percent	
Protein,	18.31 "	83.28 percent
Fat,	2.83 "	12.50 "
Ash,	1.16 "	5.22 "

Sole.—The term "sole" is applied here to certain species of flounders and the two terms are sometimes used synonymously. The true soles, however, of which there are several species, belong to a distinct though closely related family. The species of flounder to which the name "sole" is generally given is *Eopsetta jordani.* It occurs along the Pacific coast from Monterey to Puget Sound. Large numbers are taken in Monterey Bay. The average weight of this "sole" is about three pounds. It is highly esteemed as a food fish. They are dried in great numbers by the Chinese, who suspend them by strings on a frame placed on the roofs of the houses, where, after they become dry, they strike against each other when moved by the wind, producing a sound which is something like that emanating from the leaves of a forest.

Tautog.—The *Tautoga onitis* is one of the wrasse-fishes (family Labridæ) and is abundant along the Atlantic coast from New Brunswick to the Carolinas. East of New York it is commonly called the "tautog." On the New York coast it is known as "blackfish," and further south as the "oyster fish."

Tilefish.—The tilefish is interesting not because of its high food value but because of the fact that it was discovered by accident in 1879 when a fisherman off the coast of Nantucket captured 5000 pounds of a fish which was new to him. The species was also new to science. This fish disappeared as suddenly as it came and no more were caught until 1892. Since then they have been taken rather frequently. The tilefish reaches a length sometimes of three feet and a weight of 30 pounds. It is pronounced by experts to be the equal of the pompano.

Trout.—Trout, of which there are many species, are greatly prized both on account of their value as game fishes, affording sport for anglers, and because of their high palatable qualities. They belong to the same family as the Atlantic salmon and often it is difficult to distinguish by any of its common characteristics a trout from a salmon. This is especially true of trout of western America. The species of trout which are most highly prized on the Pacific coast are the cut-throat trout (*Salmo clarkii*), the rainbow trout (*Salmo iridens*), and the steel-head (*Salmo gairdneri*). The familiar silver trout of Lake Tahoe is another closely related species. They are distinguished by a remarkable system of spots of a circular form, black in color, and of varying size. The Lake Tahoe trout which is commonly secured is not the same as the silver trout of Lake Tahoe but is of a little different character, and is also known as the Truckee Trout, "Pogy," and "Snipe." It reaches a weight of from three to six pounds and is sometimes served on the dining cars of the Central Pacific Railway, in running through Idaho and into California. Various other species of the trout are found in Utah, in the Rio Grande and the Colorado, and in the lakes of Colorado. Perhaps the most important of these is the steel-head trout occurring along the Pacific coast. The rainbow trout is also a fish that is highly prized along the Pacific coast. The brook trout of western Oregon is also an important fish.

The Trout of the Great Lakes.—The fish known as trout in the Great Lakes belong to a different genus from those already mentioned, namely, genus *Cristivomer.* It has, however, the typical spots, which are of a grayish color instead of red or black like those of the other trout which have been mentioned.

The principal species which abounds in the Great Lakes is the Mackinaw trout (*Cristivomer namaycush*). It is also found in the large lakes from Maine westward to the Pacific ocean and even to northern Alaska. This is the largest species of trout. The average weight of the fish probably does not exceed 15 or 20 pounds. Individual examples have been found weighing over 100 pounds. There is only one common fish which exceeds it in weight, namely, the sturgeon. Next to the white fish it is the most important commercial fish of the Great Lakes. The supply of lake trout has been diminishing and the price increasing for several years. The spawning season of lake trout begins in September and continues until December.

Composition of Lake Trout.—

	Fresh.	Dry.
Water,	69.14 percent	
Protein,	18.22 "	60.10 percent
Fat,	11.38 "	36.80 "
Ash	1.26 "	4.90 "

Composition of Brook Trout.—

	Fresh.	Dry.
Water,	77.72 percent	
Protein,	18.97 "	86.62 percent
Fat,	2.10 "	9.16 "
Ash,	1.21 "	5.39 "

The above data show that lake trout has a flesh which approximates in composition that of Pacific salmon, being quite rich in fat, while the brook trout has a composition more like the Atlantic salmon, being very rich in protein and poor in fat. Trout of all kinds are used practically in only a fresh state. The catch is not large enough to warrant the establishment of canning factories and all that are caught in the northern and central northern lakes and streams find a ready market in a fresh state at much more remunerative prices than could be obtained by canning. It is always a fortunate circumstance when the condition of the catch and of the market are such as to enable the fish to be eaten as fresh as possible from the water. Fish is a kind of food which is never improved by keeping in any way and is at its best the minute the fish is taken from the stream. The brook trout do not belong to the same genus as the lake trout but to the genus *Salvelinus*. They have a general resemblance, however, to that genus. As a fish to be caught by the hook and as a victim of sport the brook trout perhaps occupies the highest place among the fish of the country; especially is it sought for in the mountain streams, and it occurs in most parts of the northeastern United States. It extends from Maine to northern Georgia and Alabama, especially in the Appalachian Mountains and west through the Great Lakes to the Mississippi, while in Canada it is found from Labrador to the Saskatchewan.

The brook trout has been especially cultivated by the U. S. Bureau of Fisheries and introduced into waters in the United States where it is not found naturally. The season for spawning for the brook trout is in the autumn, when the water is growing colder, and continues from August to December, according to the latitude. In spawning time the fish come up into the smallest parts of the stream where shallow water can be found. The eggs remain until the next spring, when they are hatched. The brook trout varies greatly in size, according to the magnitude of the stream. In the small streams it weighs often less than ¼ pound, while in large streams it weighs 2 or 3 pounds. The large trout has almost disappeared from the small streams as a result of the activity of fishermen.

There are many other species of trout which are known in different parts of the country. For instance, the Dublin Pond trout of Dublin Pond, N. H., the Dolly Varden trout in the northern Pacific states and Alaska, the Sunapee trout in the northeastern states, and the Blueback trout in Maine. These fishes all have practically the same quality, varying only in minute details, and have the same value as a food.

Turbot.—A species of halibut known as Greenland halibut (*Reinhardtius hippoglossoides*) is also known as turbot in this country. It occurs chiefly off the coast of Greenland, and is taken in the very coldest part of the year. The European turbot is *Psetta maxima.*

Weakfish.—The weakfish belongs to the croaker family (Sciænidæ) and has a high value as a food fish, the flesh being rich in flavor and very tender and easily disintegrated, from which quality it is believed the name "weakfish" is derived. The common weakfish is the species *Cynoscion regalis.* It is also known in some localities as the squeteague. The fish is rather long in proportion to its breadth and sometimes grows to a large size. Examples weighing over 25 pounds have been captured. Very rarely, however, does a weakfish weigh more than 10 pounds, and the average is perhaps not more than one-half that. The weakfish is, particularly when young, a victim of the bluefish, and great numbers succumb to the ravages of its more powerful enemy. The weakfish is found over the entire length of the Atlantic and Gulf coasts as far north as the Bay of Fundy. The weakfish sometimes ascends the tidal waters and congregates around the river mouths, where the food is more abundant. While found on the markets in the North, it is more highly prized in the southern markets.

Composition.—

	Fresh.	Dry.
Water	78.97 percent	
Protein	17.45 "	84.63 percent
Fat	2.39 "	11.37 "
Ash	1.19 "	5.64 "

The flesh of the weakfish, as shown by the above data, is one in which the protein exists in very much greater proportion than the fat. It is not so rich in protein, however, as some of the other species which have been mentioned.

Whitefish.—This fish occurs in large numbers in all our Great Lakes, and is an abundant article of food. Its scientific name is *Coregonus clupeiformis.* It inhabits the whole of the Great Lakes regions from Lake Champlain to Lake Superior. It does not occur in very great abundance, if at all, west of Lake Superior, although it has been reported to have been found in the fresh water lakes both to the north and west of that region.

The common whitefish prefers the deep water of the lakes, coming only into shallow water near the shore at spawning time, which, in the Great Lakes, is from October to December. During the months of January, February, and March the fishing for whitefish is practically discontinued, since the fish at that time have returned to deep water and are not accessible.

The size of the whitefish in the Great Lakes is not so great as the extent of water would indicate. Probably three pounds would be an average size, although the individual fish range from 1½ to 6 pounds. The weight rarely, however, exceeds 4 or 5 pounds. Occasionally whitefish have been found weighing as high as 20 pounds, but this is very rare. The whitefish reaches its full average size about the end of the fourth year. The number of eggs which are found in the female fish is not so large as in the shad, but usually the number does not fall below 10,000 and sometimes reaches as high as 75,000. The eggs are very small comparatively, and about 36,000 of them make a quart. The U. S. Bureau of Fisheries has done a great deal to increase the supply of whitefish by planting millions of whitefish fry in suitable water.

Different Species of Whitefish.—There are many species of whitefish besides the common whitefish which appear in the Great Lakes. Coulter's whitefish is found in the waters of British Columbia, but it is not distributed very widely throughout the country. The Rocky Mountain whitefish is very widely distributed, occurring in all suitable waters from the west slope of the Rockies to the Pacific. There is also a subspecies of this fish occurring in the headwaters of the Missouri river. Menominee whitefish occur in the lakes of New England, New York, and the Great Lakes,—it is also known as round whitefish, frostfish, shadwaiter, pilotfish, chivey, and blackback.

Composition of Whitefish.—

	Fresh.	Dry.
Water	69.83 percent	
Protein	22.06 "	76.00 percent
Fat	6.49 "	21.51 "
Ash	1.62 "	5.36 "

*Average Composition of Fish.**—

Water,	76.06	percent
Solids,	23.94	"
Nitrogen,	3.51	"
Phosphoric acid,	.52	"
Sulfur,	.24	"
Fat,	1.45	"
Ash,	1.21	"
Protein,	21.92	"

Fluorids in Fish.—Nearly all kinds of fish yield a distinct test for fluorin which is not to be mistaken for an adulteration. The fluorin is found normally in the bones of the fish and sometimes in traces in the flesh. The addition of fluorid as a preservative is highly reprehensible, and its presence is indicated by the increase in quantity.

Marketing of Fish.—In the food act it is provided that no animals shall be used for food which have died otherwise than by slaughter. Whether or not this would apply to fish is a matter of some doubt. Unfortunately fish, as a rule, are allowed to die by being deprived of oxygen, which they get from the water as it passes over their gills. The common practice is to take the fish for commercial purposes in seines or other gear and allow them to die, as it were, by suffocation. The greater number of fish exposed upon our markets have died in this way and are then packed in ice and kept until sold. The ideal way to treat fish would be to transfer them from the seine to a pool of water, fresh or salt, in which they are kept alive until they are wanted for cooking. This method is practiced in some very high-grade restaurants and hotels where the diner may pick for himself from the pool the fish he desires to eat. It is evident that for commercial purposes where a cheap food is desirable a method of this kind could not be practiced. It is a question which the hygienist as well as the practical man should consider, that is, whether or not it is possible to slaughter the fish and, as soon as they are taken, dress them, pack their carcasses in ice, and in this way deliver them to the markets. Where fish are used for canning or salting purposes they are often slaughtered as soon as caught. This is particularly true of herring captured in the Potomac and Susquehanna rivers. It is an interesting problem to study whether or not the flavor and character of the flesh are impaired by the suffocation process subsequent to their capture. In all cases except in cold weather, the fish after capture, no matter whether they are allowed to die by suffocation or slaughtered, should be packed in ice and kept until the market is reached, which should be at as early a date as possible. Fish are never so good as when fresh and the fresher the better.

Cold Storage.—Fish is a product which is often found in cold storage in large numbers and kept there for a long time. The usual problem attending

* Average analysis of cod, halibut, bass, etc., used at the hygienic table of the Bureau of Chemistry

the cold storage of food is even more important when applied to fish. In cold storage fish are frozen solid and kept in this state until ready for consumption. Just how long the palatability and wholesomeness of fish can be preserved when frozen solid has not been determined. It follows logically that the colder the temperature the less the degree of deterioration, but it does not follow logically that this temperature can be maintained indefinitely without injuring the character of the product. One thing appears to be certain, namely, that the consumer is entitled to know whether in any given case the fish he purchases is a fresh or a cold storage article. At the present time, in so far as I know, there are no national, state, or municipal laws whereby this fact can be ascertained. Without raising the question of comparative value or palatability there is no doubt but what the consumer is entitled to know the character of the fish he purchases.

Canning Fish.—Allusion has already been made to the practice of canning fish, especially salmon. Great precautions must be used in cases of this kind, since fish is a food which tends to develop poisonous principles incident to decomposition. Canned fish, therefore, must be thoroughly sterilized so that no fermentative action tending to produce ptomain poison can possibly take place. It should be the duty of inspectors of food to frequently examine packages of canned fish to determine, first, by the external appearance of the can, and, second, by opening a certain number of them, whether any decomposition has taken place. Too great care cannot be exercised in this matter, since dangerous and often fatal results follow the consumption of spoiled fish.

Drying and Salting Fish.—The preservation of fish by pickling, salting, drying, and smoking is a great industry and produces some of the most palatable products. Mackerel, herring, and cod are types of fish which upon proper curing make a most delectable dish. Nothing but encouragement should be given to industries of this kind, but in order that they may be of the most value they should be conducted properly with due regard to hygienic principles and for the sole purpose of making a wholesome and palatable product.

Adulteration of Fish Products.—Attention has already been called to the adulteration of salmon by canning an inferior grade or even a different kind of fish under the name of a better species. The same remark may be made respecting all fish, hake, haddock, and cusk being often offered as cod. In the case of sardines a similar practice is in vogue, and the small herring which are captured off the coast of Maine are often sold under the name of sardines. The substitution of one variety of fish for another, however, is injurious only in the way of fraud, the substitute fish presumably being of equal wholesomeness to the other under whose name it is sold. On the contrary, the form of sophistication which permits the introduction of deleterious substances into fish food is highly objectionable from the dietetic point of view. Following the general principles of nutrition, all chemical, non-condimental preservatives are to be rigidly excluded from fish products. This rule excludes boric acid, borax, benzoic acid and benzoates, sulfites, formaldehyde, and all other forms of chemical preservatives.

When fish are packed in oil the character of the oil used should be made known to the consumer. Especially is this true if from the locality where the fish is preserved and the general method of packing the consumer is led to believe that a high-grade oil such as olive oil has been used.

Value of Fish as Food.—From the statements which have been made in connection with fish in particular and the analyses which have been given it is seen that fish is a food of a peculiarly nitrogenous character. The edible portions, exclusive of water, are at least three-fourths, and probably more, composed of protein. The other edible nutritive product is fat or fish oil. The mineral nutrients compose the remaining edible portion of fish after the protein and fat are considered. The mineral portions of fish cannot be regarded as not nutritious since they contain phosphoric acid and lime, which are essential ingredients of food. The flesh of fish, however, as it has been seen, is not a complete ration, but is lacking in carbohydrates, and for this reason fish should be eaten with potatoes, rice, or other highly starchy foods. The value of fish as a food is unquestionable and its more general consumption would doubtless prove beneficial.

Those who live in the interior of large and extensive regions where fresh water fish are not very abundant do not appreciate the value of fish as food as do those who live upon the coasts washed by salt water and near the interior fresh waters where an abundant supply of fish is secured.

SHELLFISH.

Clams.—Clams are shellfish which, though not so extensively used as the oyster, are valued food products. The clams of commerce are of two kinds. The species known as long or soft clam is abundant on the New England coast, and is of considerable commercial importance both fresh and as a canned product. This is the clam used at clam bakes, for which the New England coast is famous. Its technical name is *Mya arenaria.*

The other species, the round or hard clam, northward known as quahog, is the most common clam of the markets south of New York. Its scientific name is *Venus mercenaria.*

A very small round clam is known as the little neck. This has a flavor which is extremely delicate and it takes the place, in the warm months, of the blue point oyster on the menus of the hotels and restaurants. The clam may be considered as a supplemental shellfish to the oyster, being most delicious and most abundant during the closed oyster season. The average weight of the round clam is about 60 grams, of which about one-fourth is flesh, one-fourth liquid, and one-half shell and refuse. There are many specimens very much larger than this but the weight is given for those usually eaten.

Composition of Clams.—Edible portion:

Water,	78.57	percent
Protein,	14.86	"
Fat,	1.78	"
Ash,	2.49	"
Undetermined,	2.30	"

The liquid which escapes upon the opening of the shell is composed chiefly of water and salt and its composition is as follows:

Water,	96.02	percent
Protein,	.65	"
Fat,	None	
Common salt,	2.81	"
Undetermined,	.52	"

The flesh of clams, it is seen, is not very different from that of fish in general. It is composed chiefly of water and of the nutrients the protein is the predominating constituent. The ash content is somewhat higher than is the case with fish.

If the flesh and fluid substance of the clam be considered together the composition of the whole mass is represented by the following data:

Water,	86.11	percent
Protein,	8.71	"
Fat,	1.01	"
Ash,	2.63	"
Undetermined,	1.54	"

Composition of Water-free Substance of the Flesh.—

Protein,	69.37	percent
Fat,	8.32	"
Ash,	11.64	"
Undetermined,	10.67	"

Composition of the Dry Substance of the Liquid Portion.—

Protein,	16.37	percent
Fat,	.10	"
Ash,	70.41	"
Undetermined,	13.12	"

Composition of the Dry Substance of the Flesh and Liquid Together.—

Protein,	62.81	percent
Fat,	7.30	"
Ash,	18.92	"
Undetermined,	10.97	"

The Lobster (*Homarus americanus*).—The lobster is a crustacean which occurs along the northern Atlantic coast. Formerly it was so very abundant that it was almost a drug on the market. In the last quarter of a century the increase in the consumption of the lobster has been more rapid than the increased growth, so that the price has become higher and higher; and this, to a certain extent, is limiting the consumption. The coast of Maine is especially the fishing grounds for the American lobster, though it is found much further south and also in great abundance further north. The lobster varies greatly in size. The law, at the present time, prevents very young lobsters from being sent into commerce. They are usually from 10.5 to 15 inches in length, though occasionally examples of enormous size are taken. The edible portion of the lobster is the liquid and the flesh of the body, claws, and tail. Only about one-half the weight of the lobster, including the liquid, therefore, is edible. The rest is refuse. In a lobster weighing a thousand grams (2.2 pounds), five hundred grams (1.1 pound) will be the average edible portion, and the other half the refuse and loss. The average lobster of the present day, perhaps, weighs scarcely two pounds, though in former times the weight was very much greater because the younger and smaller lobsters were not sent to the market. The color of the lobster as it comes from the water is dark green, almost black at times. Heat changes the color of the shell, so that after boiling or baking the lobster becomes red. The flesh of the lobster is decidedly sweet, owing to the large quantity of glycogen which it contains. There is only one kind of meat that is eaten which approaches the lobster in its content of glycogen, and that is horse meat.

Composition of the Lobster.—Edible portion:

	Fresh.	Dry.
Water,	84.30 percent	
Protein,	11.63 "	74.06 percent
Fat,	1.82 "	11.62 "
Ash,	1.63 "	10.38 "
Glycogen,	.62 "	3.94 "

Crabs.—The crab is a shellfish very highly prized along the whole of the Atlantic coast. Numerous species of crabs are used for food. These are used in two forms—as hard-shelled or soft-shelled crabs. The species most valued is *Callinectes hastatus*. It is very abundant on the middle and south Atlantic coast. Crabs are quite abundant on the Pacific coast also. About 44 percent of the total weight of the crab is edible and 56 percent shell and refuse. In the edible portion about 77 percent is water and 23 percent solid matter.

Composition of the Water-free Substance of the Crab.—

Protein,	72.56 percent
Fat,	8.55 "
Ash,	13.64 "

The flesh of the crab is, therefore, essentially a nitrogenous food, containing only a small quantity of fat. A considerable portion of the ash is common salt.

Crawfish.—The crawfish may be regarded as a fresh-water lobster. It is found practically over the whole of the United States in the fresh waters but is not used to any extent for food purposes, except on the Pacific coast. It contains even a less proportion of edible matter than the lobster. The refuse, shell, etc., form about five-sixths of its weight. In the edible portion the water constitutes 81.22 percent, while the solid matters are only 18.78 percent.

Composition of the Water-free Substance of the Crayfish.—

Protein,	85.19	percent
Fat,	2.45	"
Ash,	6.98	"

Canned Lobster, Clams, and Crabs.—As in the case of oysters, there is a large industry in the United States engaged in the canning of the flesh of lobsters, clams, and crabs. The same precautions should be observed in the eating of these canned products as those mentioned in the case of salmon. Numerous instances of illness and sometimes of death have been recorded as the result of eating these canned products which have been imperfectly sterilized. When the flesh is canned immediately after the capture of the animal, before any incipient decomposition has taken place and when the sterilization is perfect, the canned product can be eaten without fear. Where the health of the people is so seriously involved, the factories where these products are prepared should be carefully inspected either by the municipal, state, or federal authorities. All material used in canning which is not perfectly fresh from the water is to be rejected and the processes employed in the preparation and sterilization must be those which will effectively secure a complete immunity from subsequent fermentation and the development of ptomain products.

Composition of Canned Lobster (Dry Substance).—

Protein,	81.46	percent
Fat,	4.64	"
Ash,	11.23	"

As seen from the above the composition of the dry substance in canned lobster, except content of water, is not perceptibly different from that of the fresh sample.

Composition of the Dry Substance of Canned Crabs.—

Protein,	79.10	percent
Fat,	7.55	"
Ash,	9.68	"

Shrimp (*Crangon vulgaris*).—The shrimp is a highly valued article of ɔd, especially when it can be had fresh or properly canned. It has been a actice to ship shrimps in bulk preserved with sulfites or boric acid. This a most reprehensible form of adulteration.

Canned Shrimps.—In the total dry edible portion, including solids in ꞔ liquid contents of the can, are found:

Protein,	86.89 percent
Fat,	3.44 "
Crude ash,	8.84 "

In edible portion (flesh plus liquids):

Water,	70.80 percent
Water-free substance,	29.20 "
Protein,	25.38 "
Fat,	1.00 "
Crude ash,	2.58 "
Extractives,	0.24 "
Nitrogen,	4.06 "
Total edible portion,	100.00 "

Γhe above data show that the shrimp in the canned state has less water in han in the fresh state, and contains one-fourth of its weight of protein.

Aquatic Reptiles.—All forms of turtle may be used for edible purposes, :h of the fresh-water and salt-water species. Both the turtle and terrapin : amphibious animals; that is, they can live either in the water or on the .d. Among the turtles the marine variety known as the green turtle is most hly prized for food purposes. Its Latin name is *Chelonia mydas*. It grows netimes to an enormous size, weighing several hundred pounds, and specins weighing 50 and 100 pounds are not unusual. It is utilized chiefly for king soup, and green turtle soup is considered of high quality by experts. e flesh is also edible, and in the making of some varieties of green turtle soup ces of the flesh are included.

Composition of the Green Turtle.—The edible portion of the green turtle the following composition:

Water,	79.78 percent
Protein,	19.83 "
Fat,	.53 "
Ash,	1.20 "

ʼhe edible portion of the green turtle is not very large in porportion to weight, as it forms only from 20 to 24 percent of the whole weight of turtle.

.mong the reptiles there are several aquatic species which are used as food. ꞔ most noted of these is the diamond-back terrapin, which is found in the -water bays, lagoons, and marshes of our Atlantic coast from New Jersey ʼexas. Its center of greatest abundance is in Chesapeake Bay. There is ish or other water animal tha' has a higher value for edible purposes than the terrapin. The extreme delicacy of its flavor, the richness of its aroma, and its easy digestibility give to it a rank which perhaps no other usual food product possesses. In addition to this the increased scarcity of the terrapin, especially the more famous variety of it, namely, the diamond-back, has gradually increased the cost until at the present time the terrapin is eaten only by the rich. In the United States it exists along the whole Atlantic coast from New York southward and also along the Gulf coast. Formerly it was most abundant on the Maryland coast, but the nearness of this field to the great markets of the country has resulted in such a depletion of the stock as to make the terrapin very scarce. Many attempts have been made at artificial growing of terrapin and these have been more or less successful, but have not met with the pronounced success which was expected. The enclosure in which the terrapin are kept, viz., the "crawl," is a feature in the artificial cultivation or breeding of these marine vertebrates. It is to be hoped that greater success in the future will attend the artificial breeding of terrapin, since the natural stock seems well on the way to extinction.

Composition of the Terrapin.—Edible portion:

	Fresh.	Dry.
Water,	74.47 percent	
Protein,	21.23 "	83.13 percent
Fat,	3.47 "	13.59 "
Ash,	1.02 "	3.99 "

The Mussel.—The mussel may be described as a fresh-water oyster. It occurs in almost all parts of the United States in the fresh waters and in external appearance resembles to some extent the oyster, but the shell is usually smoother. In the mussel is often developed concretions of the carbonate of lime in a particular form known as pearls. In fact the chief value of the mussel is in the supply of pearls which they furnish, since their flesh, although often eaten, is not considered very palatable nor desirable. Pearls may be found in mussels in every locality, but in some regions they are more abundant than in others,—for instance, the mussels of Wisconsin are especially noted for the occurrence of the pearls. Pearls are also frequently found in oysters, but by no means so frequently as in the mussel.

Composition of the Mussel.—The edible portion of the mussel forms about one-half its weight.

Water,	78.64 percent
Protein,	12.51 "
Fat,	1.67 "
Ash,	1.73 "
Undetermined,	5.45 "

Oysters.—Oysters belong to a class of animals known as mollusks. They grow in salt or brackish water and are found along almost the whole the coast of the United States. They exist in the greatest abundance ıg the coast in the vicinity of Long Island Sound, Norfolk, Virginia, along coast of the Gulf of Mexico, off the coast of Mississippi, Louisiana, and ɛas, and along the Pacific coast from San Francisco to the northern limits Vashington.

ize.—The size of an oyster depends greatly upon its food and also upon species. There are some varieties which at a given period of growth naturally very much larger than others. The larger variety grows near rfolk and along the Gulf coast. A smaller species is especially abundant the Pacific coast, though a number of very large specimens of oysters e been found on that coast.

ge.—An oyster is eaten at any time after two years. Oysters, however, ee or four years old are, perhaps, in all respects the best. The age is ermined largely by the appearance of the shell, experts being able to ctically determine the age of an oyster by an examination of the shell.

The oyster grows within a shell which is composed almost exclusively of bonate of lime. The periphery of the shell is ovoid in shape, irregular, l the surface, especially of old oysters, is corrugated, rough, and unattractive. e interior of the shell is smooth and generally white, but sometimes has lue or reddish tinge. The shells of edible oysters vary in size from 2 to nches in length and from 2 to 4 inches in width. The oysters sold in the rket are known by various names, usually derived from the location from ich they come. A small variety distinguished by a blue color on the ide of the shell is known as blue points. The real blue points come only m Long Island. Another variety named Rockaway is also a Long Island iety, and should come exclusively from Rockaway or vicinity. Shrewsbury another highly prized variety from the neighborhood of Shrewsbury, New sey. Buzzards Bay, James River, Norfolk, Lynnhaven, Rappahannock, ny Creek, Saddle Rock, etc., are names commonly found in the trade. fortunately, the name of the location is not always an indication of the ual source from which the oysters may have come. For instance the term lue point" is now very commonly given to small oysters not exceeding 2 2½ inches in length with a correspondingly diminished breadth. On contrary "saddle rock" is a name given to very large oysters no mat- from what region they may come. It is a common practice to separate oysters taken from one location into groups of similar size and attach to h group a special name which may or may not be indicative of location.

ultivation of Oysters.—The natural beds of oysters are rapidly exhausted the free fishing which is in some cases allowed, and the supply must be ot up by proper cultivation. Oyster farming has become a great industry ng all parts of the coasts where the conditions are well suited to culture. e ideal conditions are inlets where the oysters are protected from the action of ocean waves and where abundant food can be derived from the low marshy grounds in the vicinity. The laws in force in the states protect the oyster farms from poachers and deeds are given for oyster beds which are beyond the low water line. The conditions of culture vary in various states. The public beds are also protected by law in many states and incipient war is sometimes carried on between the authorities of one state and the poachers from other states. Maryland, especially, has laws of a very strict character respecting the taking of oysters, and the state furnishes armed forces for the protection of public beds.

Season for Oysters.—The best season for oysters on the Atlantic coast of the United States extends from September first to May. These dates may also be applied to oysters of the Gulf and Pacific coasts. It is commonly said that all months which have an "R" in them are suitable for eating oysters. In point of fact oysters are eaten the year round, especially on the Atlantic coast, though to a very limited extent during the spring and summer months. Those who own their own oyster beds are privileged to take oysters at all seasons, and it is not unusual for a restaurant to furnish oysters during the whole year, those in the closed season being derived from private beds.

Life of an Oyster.—After an oyster is taken from its bed it may be kept alive for a long time at a temperature which does not rise too high nor sink too low. The best temperature for keeping oysters alive is about 40 to 50 degrees Fahrenheit. The oysters should be protected from the sunlight by a proper covering in a cool place and kept moist with sea water or brine which is sprinkled over them in such a way as to come in contact with each oyster in the heap. Oysters kept under these conditions often remain in an excellent state for consumption for a week or ten days or even longer. If such conditions are maintained oysters may be shipped in bulk to all parts of the country in cars kept cool, and this is the best way in which to distribute oysters for consumption in a fresh state.

The treating of oysters with fresh water in order to swell them and thus make them appear larger and plumper than they really are is a treatment which is reprehensible in every respect. Not only does it deceive the customer in regard to the size of the oyster but it deprives the oyster of its proper taste and flavor. "Soaked" oysters quickly lose their flavor, whereas the oysters kept as above described and sprinkled with brine retain their natural flavor and odor. The objection to the transportation of oysters in this way is that the shell usually weighs many times more than the oyster and the same rate of freight must be paid upon it as upon the oyster itself. Nevertheless, the fact remains that fresh oysters are best immediately after removal from the shells. As soon as the shell is removed and the oyster killed by this removal it begins to deteriorate and in a short time its flavor and aroma are impaired. It is a common practice in many cities, even where oysters are delivered fresh daily from their beds, to open large quantities of them and put them in tubs and sell them from these tubs to customers. It thus happens that customers often buy oysters that have been opened 24 hours or more and which are naturally of a very inferior flavor. Strict regulations in regard to the use of fresh oysters, favoring their being opened when they are ready for consumption or requiring that they should be kept in a condition of palatability and properly cooled until ready for consumption, should be observed.

Shipment of Opened Oysters.—Opened oysters are shipped extensively to all parts of the country. After removal from the shell the oysters are washed to remove the natural water, since this becomes ropy during shipment. They are then packed in wooden tubs of various sizes, a piece of ice added, covered, and delivered to the fast express or freight service. The shipment of shucked oysters to which water has been added either directly or in the form of melted ice is deemed unlawful, because a substance, *i. e.*, water, has been mixed and packed with the oysters so as to reduce or lower or injuriously affect the quality or strength. It is highly advisable to ship shucked oysters surrounded by ice but not in contact with it. Oysters thus shipped retain their flavor and palatability to a remarkable degree and are not contaminated by ice.

Proportion of Shell and Oysters.—The following illustration (Report of the U. S. Commissioner of Fish and Fisheries for 1888, page 784) shows the relative proportion of the flesh, liquid, and refuse for two or three varieties of oysters:

Name: Oysters ("East Rivers").
Locality: Cow Bay, Long Island Sound, New York.
Received: April 8, 1881, from E. G. Blackford.
Description: Length, 2½ to 5½ inches; breadth, 1¾ to 3½ inches.

WEIGHINGS IN PREPARATION FOR ANALYSIS.

	Grms.	Lbs.	Oz.	Percent.
Flesh,	558.0	1	3.6	10.27
Liquid,	543.7	1	3.1	10.01
Refuse (shells, etc.),	4,284.7	9	7.2	78.86
Loss,	47.3	..	1.7	.86
Total, 51 oysters,	5,433.7	11	15.6	100.00

Name: Oysters ("Sounds").
Locality: Princess Bay, Staten Island, New York.
Received: November 30, 1881, from Dorlon & Shaffer, New York City.
Description: Thirty oysters in shell.

WEIGHINGS IN PREPARATION FOR ANALYSIS.

	Grms.	Lbs.	Oz.	Percent.
Flesh,	384.0	..	13.5	8.24
Liquid,	436.0	..	15.4	9.35
Refuse,	3,816.0	8	6.6	81.87
Loss,	25.0	..	0.9	0.54
Total, 30 oysters,	4,661.0	10	4.4	100.00

The above data show that for 100 pounds of shelled oysters only about 10 pounds of meat are found. There is also about 10 pounds of liquid or juice that escapes when the oyster is opened. There is an average of 80 pounds of shell and other refuse. When it is remembered that, as will be shown in the table given below, in 10 pounds of the meat there is over 80 percent of water it is seen that the actual nourishment contained in 100 pounds of oysters is reduced to a little over 1 pound. There is a general opinion that oysters are a very nutritious food and this is true in so far as the nitrogenous element of food, that is, the protein, is concerned, and in proportion to the quantity present. As a nourishing food the oyster cannot be considered as of any very great importance. It must be confessed that it will continue to be used, as it has been in the past, practically as a condimental food substance and not solely to satisfy hunger nor provide heat and energy for the body.

Process of Floating.—Reference has been made to the practice of soaking shell oysters in fresh water for the purpose of making them more plump and increasing their weight. This, in the language of the fisherman, is called "floating," "drinking," or "laying out." By this process the body of the oyster affects a plumpness and largeness which materially increases its selling qualities, as it increases its weight and size and, therefore, the profits of the dealer. The principle of this process depends upon the fact that when a soft substance like an oyster, containing a mineral salt in its composition, is brought in contact with water, a process of diffusion takes place which is known in chemical physics as osmosis, whereby water passes through the cell walls and enters the cells of the oyster and the mineral substance thereof is forced out into the external water. Larger volumes of water pass into the cells than accompany the particles of mineral matter to the outside of the cells and the result is a swelling of the oysters and consequent increase in the size and weight by the addition of pure water, but at the expense of the natural salt, mostly chlorid of sodium or common salt, which the oyster contains.

The U. S. Bureau of Fisheries has been experimenting to show the change which takes place with the following results:—

STATISTICS OF WEIGHTS, ETC., OF SPECIMENS OF OYSTERS.

Constituents.	James River.*						Potomac River.*					
	From beds.			From floats.			From beds.			From floats.		
	Lab. No. 82; 31 oysters.			Lab. No. 83; 34 oysters.			Lab. No. 85; 35 oysters.			Lab. No. 84; 41 oysters.		
Shell contents:	*Grms.*	*Lbs.*	*Oz.*	*Grms.*	*Lbs.*	*Oz.*	*Grms.*	*Lbs.*	*Oz.*	*Grms.*	*Lbs.*	*Oz.*
Flesh (body)	312.5		11.0	412.5		14.5	302.5		10.7	415.5		14.7
Liquids (liquor)	181.5		6.4	208.0		7.3	282.0		10.0	264.3		9.3
Total	494.0	1	1.4	620.5	1	5.8	584.5	1	4.7	679.8	1	8.0
Refuse:												
Shells	2778.0	6	2.0	2976.0	6	9.1	3017.0	6	10.4	3386.0	7	7.4
Loss†	21.0		0.8	17.5		0.6	22.5		0.8	15.2		0.5
Total	2799.0	6	2.8	2993.5	6	9.7	3039.5	6	11.2	3401.2	7	7.9
Total weight of specimen	3293.0	7	4.2	3614.0	7	15.5	3624.0	7	15.9	4081.0	8	15.9

* Transplanted to beds in New Haven harbor, Connecticut, in April, and taken for analysis the following November.

† Loss in opening and weighing, chiefly water.

COMPARATIVE PERCENTAGE COMPOSITION OF OYSTERS BEFORE AND AFTER "FLOATING."

CONSTITUENTS OF OYSTERS.	JAMES RIVER OYSTERS TRANSPLANTED TO NEW HAVEN.		POTOMAC RIVER OYSTERS TRANSPLANTED TO NEW HAVEN.	
	As taken from beds.	As taken from floats.	As taken from beds.	As taken from floats.
	No. 82.	No. 83.	No. 85.	No. 84.
In whole specimen:				
Shell contents:	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Flesh	9.49	11.41	8.35	10.18
Liquids	5.51	5.76	7.78	6.48
Total shell contents	15.00	17.17	16.13	16.66
Refuse:				
Shells	84.36	82.35	83.25	82.97
Loss in preparation for analysis	0.64	0.48	0.62	0.37
Total refuse	85.00	82.83	83.87	83.34
Total constituents, shell contents, and refuse	100.00	100.00	100.00	100.00
In flesh (body):				
Water	77.99	82.77	77.90	82.06
Water-free substance	22.01	17.23	22.10	17.94
Total flesh	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	1.70	1.40	1.65	1.45
Protein (nitrogen × 6.25)	10.63	8.79	10.31	9.09
Fat (ether extract)	2.61	1.91	2.33	1.93
Ash	2.21	1.55	2.17	1.58
Carbohydrates, etc. (by difference)	6.56	4.98	7.29	5.34
Total water-free substance	22.01	17.23	22.10	17.94
In liquids:				
Water	94.74	95.22	94.99	95.69
Water-free substance	5.26	4.78	5.01	4.31
Total liquids	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	0.31	0.34	0.29	0.33
Protein (nitrogen × 6.25)	1.95	2.09	1.81	2.05
Fat (ether extract)	0.04	0.13	0.02	0.01
Ash	2.54	1.42	2.47	1.19
Carbohydrates, etc. (by difference)	0.73	1.14	0.71	1.06
Total water-free substance	5.26	4.78	5.01	4.31
In total shell contents, flesh, and liquids:				
Water	84.15	86.95	86.14	87.36
Water-free substance	15.85	13.05	13.86	12.64
Total shell contents	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	1.19	1.05	0.99	1.02
Protein (nitrogen × 6.25)	7.44	6.54	6.20	6.37
Fat (ether extract)	1.66	1.31	1.21	1.18
Ash	2.32	1.50	2.32	1.43
Carbohydrates, etc. (by difference)	4.43	3.70	4.13	3.66
Total water-free substance	15.85	13.05	13.86	12.64
In whole specimen:				
Shell contents:				
Water	12.62	14.93	13.89	14.55
Water-free substance	2.38	2.24	2.24	2.11
Total shell contents	15.00	17.17	16.13	16.66
Refuse	85.00	82.83	83.87	83.34
Total shell contents and refuse	100.00	100.00	100.00	100.00

COMPARATIVE PERCENTAGE COMPOSITION OF OYSTERS BEFORE AND AFTER "FLOATING."—(*Continued.*)

CONSTITUENTS OF OYSTERS.	JAMES RIVER OYSTERS TRANSPLANTED TO NEW HAVEN.		POTOMAC RIVER OYSTERS TRANSPLANTED TO NEW HAVEN.	
	As taken from beds.	As taken from floats.	As taken from beds.	As taken from floats.
	No. 82.	No. 83.	No. 85.	No. 84.
In whole specimen:	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Shell contents:				
Nitrogen	0.18	0.18	0.16	0.17
Protein (nitrogen × 6.25)	1.12	1.12	1.00	1.06
Fat (ether extract)	0.25	0.22	0.20	0.20
Ash	0.35	0.26	0.37	0.24
Carbohydrates, etc. (by difference)	0.66	0.64	0.67	0.61
Total water-free substance	2.38	2.24	2.24	2.11
Water	12.62	14.93	13.89	14.55
Total shell-contents	15.00	17.17	16.13	16.66

Result of Treatment.—As shown by the data the first result is one which would naturally be expected, namely, that the total weight of the oyster thus inflated with water is increased relatively to the total weight of the shell since no change takes place in the weight of the shell during floating. The gain of weight in the oyster is due to the absorption of the water, although there is a loss of mineral salt. The average gain of the oyster was, in round numbers, 10 percent. The danger of infecting oysters thus treated with any germs, which may be present in the water or ice used, should also be taken into consideration.

In respect of the composition of the oyster itself when subjected to floating the chief change is in the increase of the water content. As has already been said the process of floating is fatal to the flavor and palatability of the product.

Adulteration.—The chief adulterations of oysters are the "floating" above described and the treatment of the "shucked" oysters with formaldehyde, boron compounds, and other preservatives to keep them from spoiling. These processes are thoroughly reprehensible and are rapidly disappearing. The consumer who lives near the source of supply should never eat any but freshly shelled oysters and those at a distance confine themselves to the properly prepared and shipped article. The chief delight of the epicure is the freshness, and not the quantity of nourishment of this justly prized bivalve.

Average Composition of Fried Oysters:

Water,	60.08	percent
Solids,	39.92	"
Nitrogen,	1.56	"
Phosphoric acid,	.42	"
Sulfur,	.19	"
Fat,	9.48	"
Ash,	1.77	"
Protein,	9.73	"
Carbohydrates by difference,	18.33	"

ANIMAL OILS.

The same distinction is made between oils and fats from animal products as has been made for the vegetable preparations further on. An animal fat remains solid or semisolid at the ordinary temperature of the living room. An animal oil, on the other hand, is one which at ordinary temperature is a liquid. Animal oils, as a rule, are not used for edible purposes directly, but are used to some extent in cooking, and to a large extent as medicinal food. Inasmuch as these oils are used for medicinal food purposes, those which are most important in this use may be very properly described in this manual. As these oils are derived both from sea and land animals they are often conveniently divided into marine animal oils and terrestrial animal oils. There is also a marked difference as a rule between the oils of marine origin and those of terrestrial origin. The oils of marine origin, as a rule, have a very high iodin number while the animal oils of terrestrial origin have an iodin number not much greater than the fats from which they are derived. This distinction corresponds somewhat closely to those vegetable oils which belong to the drying and non-drying variety. The iodin number represents the percentage of iodin absorbed by a unit weight of substance. If one gram of an oil absorb 0.67 gram of iodin, the iodin number is 67. The marine oils correspond to the dry vegetable oils and the terrestrial oils to the non-drying vegetable oils. While this difference is one which is marked, it does not always exist in each individual case.

Marine Animal Oils.

The marine animal oils may be conveniently divided into fish oils, liver oils, and blubber oils. Of these the liver oils are the most important from an edible point of view or a medicinal edible point of view. The fish oil and blubber oil are used chiefly for illuminating and other technical purposes.

Fish Oils.—These are obtained by rendering from all parts of a fish where fat exists. The herring, sardine, salmon, and the menhaden are the fish which are chiefly used for getting oil of this kind. The fish oils have very much improved in quality since the steamer has taken the place of the sail boat for gathering the fish. During the days of the sail boat the fish were often kept for ten days after seining before they were brought ashore. The decomposition which took place would naturally affect the oil. At the present day the steamers fishing close to the shores deliver their products much more frequently, often the same day they are caught, and thus a better quality of oil is produced. In this country menhaden is the chief fish used for obtaining oil. The scientific name of menhaden is *Brevoortia tyrannus*. These fish appear in enormous quantities around the Atlantic coast from May until November. It is estimated that nearly one-half million tons have been taken of these fish during a season. Menhaden oil is rarely if ever used for edible purposes. It is used principally in the leather trade and sometimes in the adulteration of cod liver oil made in Newfoundland.

Sardine Oil.—Sardine oil is principally prepared in Japan from the Japan sardine (*Clupea sardinus*). It is not used to any extent for edible purposes. It is also prepared to some extent in the boiling of sardines in France preparatory to packing in oil.

Salmon Oil.—This oil is obtained in large quantities on the Pacific coast. It is one of the fish oils which has an agreeable odor and taste and, therefore, can be used for edible purposes. It has a specific gravity at 15 degrees of about .926 and its iodin number is about 160.

Cod Liver Oil.—The most important of all the animal oils for food purposes is the oil which is obtained from the liver of the cod (*Gadus callarias*). Cod liver oil is valuable for food purposes not on account of its odor and taste, which are usually quite disagreeable, but by reason of the specific effect which it is often said to exercise in cases of emaciation and general disorder of the functional activities of the body. It is a food or medicine, whichever it may be best called, which is highly prized in tuberculosis and similar diseases. The oil is chiefly prepared in the Loffoden Islands. Different classes of oil are prepared which are differentiated chiefly by their color, the lighter the color the higher the quality of the oil. The chemical composition of cod liver oil is extremely complex, many different kinds of substances having been found in it by various authorities. The probability is that many of these supposed substances are only mixtures of others. Yet it cannot be denied that the number of chemical compounds occurring in cod liver oil is very much greater than that which occurs in ordinary oils. Both the medicinal and food values of the oil are often attributed to these bodies which occur in minute quantities.

Properties.—Cod liver oil at 15 degrees has a specific gravity of .922. Its iodin number varies very greatly but is always high, ranging from 150 to 180. Its refractive index is also very high, namely 1.47.

An important constituent of cod liver oil is cholesterol. Cod liver oil contains naturally a small quantity of iodin and this natural compound of iodin is one of the properties to which much of its medicinal virtue has been attributed. The quantity present is extremely minute, and probably never exceeds .002 of one percent.

Adulteration of Cod Liver Oil.—Owing to its increasing price cod liver oil has been subjected to many forms of adulteration. The chief adulteration consists in the admixture of fish liver oil of lower quality or the use of blubber oil. Seal and whale oils have been used very extensively in the adulteration of cod liver oil. Japan fish oil and, in fact, all other fish oils which are of a character not to disguise the properties of cod liver oil have been used.

It is evident that it is with extreme difficulty that the presence of these adulterants can be detected, especially if they are used in small quantities. The only certain method of guarantee of the purity of a cod liver oil is in the proper inspection and control of the manufacturing works. The livers of many other kinds of fish are employed in the manufacture of cod liver oil, but the other varieties have little value as compared with the cod liver oil itself and they are probably used almost exclusively in the adulteration of the genuine article. The Norwegian cod fish has been said to give a much better oil than those coming from the Atlantic coast of America. This is true only of the low grade American product; the high grade is as good as the Norwegian.

Blubber Oil.—Blubber oil includes the oils made from seals, whales, turtles, etc., and is used exclusively for technical purposes, unless surreptitiously placed in cod liver oil as an adulterant.

PART IV.

MILK AND MILK PRODUCTS AND OLEOMARGARINE.

MILK.

Limitation of Name.—By the term "milk," unless qualified in some way, is meant a lacteal secretion of the healthy cow, free of colostrum and of standard quality. If the milk of other mammals is meant the name of the class of animal is used in connection with the term, such as ewe's milk, goat's milk, etc. Milk is one of the most important articles of commerce and, by reason of its composition, high nutritive character, and easy digestibility, it is not only the natural food of infants but a most important food for children and adults. It is also an indispensible food in many, if not most, cases of disease where nutrition is impaired. In some cases life may often be sustained over a critical period by the use of milk as a food where other forms of food would fail of digestion and prove injurious instead of beneficial. The discussion of milk as infants' and invalids' foods is found in Part X.

Average Composition of Milk.—Perhaps there is no food substance which has been subjected to so many and such severe analytical tests as milk. Hundreds of thousands of analyses have been made in all civilized countries, not only of the milk of the individual cow but of herds of greater or less size.

There is a great variation in the composition of milk of different breeds of cattle and also of different individuals of the same breed. For instance, the Holstein breed of cattle affords a milk with a very low content of fat, sometimes as low as 3.25 percent, and in individual cases lower. On the other hand the Jersey breed of cattle affords a milk of a very high content of fat, sometimes reaching as high as 6 percent, and in individual cases very much higher. The content of the nitrogenous element in milk is more stable than that of fat and the common content of casein in milk ranges from 2½ to 3½ percent. The sugar in the milk is usually the complementary substance with the fat, diminishing in relative proportions as the fat increases and vice versa. The average content of sugar in cow's milk is approximately 4 percent. The content of mineral substances in milk is also quite constant, being about 0.70. The ash contains the phosphoric acid which is one of the essential food components of milk. A milk of fair average quality contains 12 percent of solids and 88 percent of water. This is an expression for milk during the various seasons of the year and from all breeds and kinds of cows. The influence of season has much to do with the quantity of milk produced. It is always greater in the spring and summer months, when the cows are turned out to pasture and the growth on which they feed is unusually succulent. The increase in volume is not attended with a proportionate increase of solids, and thus the percentage of solids in spring and summer milk is less than that in the winter milk unless the cows are particularly well fed during the winter on a generous diet, including large quantities of roots.

The character of the milk is greatly influenced by the environment in

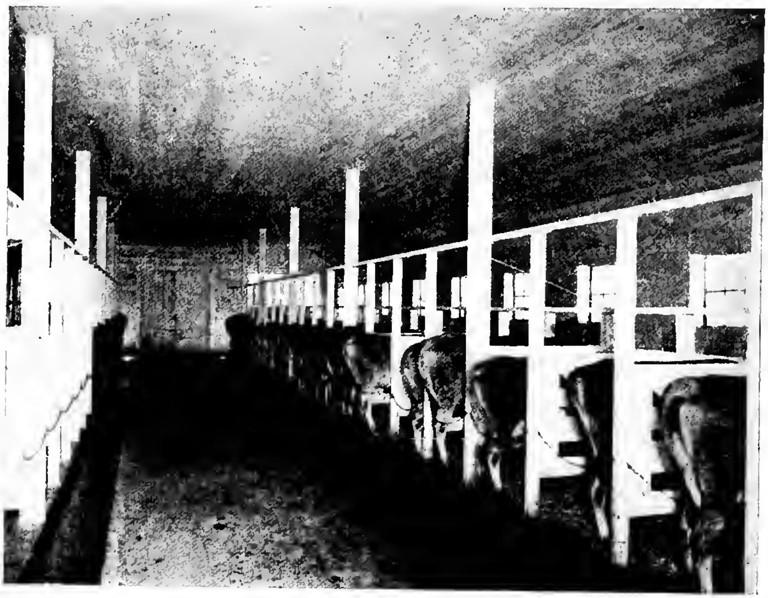


FIG. 13.—COW STABLES, MAPLETOWN FARM, SUMNER, WASHINGTON.

which the cow lives. The stable in which the cow is kept should be clean, well ventilated, and protected against extreme changes in temperature, thus being cooler in the summer than the hot air on the outside and much warmer in the winter. An excellent arrangement of the stables to secure cleanliness and good ventilation is shown in Fig. 13. Cows should be supplied with an abundant quantity of pure water and should not be allowed access to stagnant pools when pasturing in the summer. Every animal giving milk should be examined from time to time by a competent veterinarian to determine, by the injection of serum or otherwise, whether or not the animal is afflicted with tuberculosis. Every animal infected with tuberculosis should be separated from the herd and destroyed. Tuberculosis is an infectious disease and may spread from a single cow to every one in the herd. It is still by some authorities claimed that there is no authentic case of transmission of bovine tuberculosis to the human system. Other authorities hold that such transmission is possible, even if it has not been proven in a particular case. Since experts disagree on this point the same rule is applicable here as in other cases of the same kind, namely, where experts disagree on a point relating to the public health the benefit of the doubt, if any, should be given to the public, and the advice of those experts followed which is the most radical respecting the protection of health from infection of any kind. It would be difficult to prove, for example, in any case of tuberculosis in man that it had been contracted from the sputa of tuberculosed patients, yet because it is possible, in the opinion of many experts, that such infection and transmission of disease can take place, it is the part of wisdom to guard against it.

It is, I think, a statement which will be accepted by all that it is possible in this country to secure and keep a sufficient number of healthy cows to give the milk supply of the nation. Therefore, it is the duty of the state, either by municipal, state, or federal inspection, to eliminate, as far as possible, and, if necessary, at the expense of the state, every diseased animal from the dairy herd. The farmer whose herd becomes infected through no fault of his can justly claim a compensation for the destruction of his animals for the common good. There is, perhaps, no more important point connected with maintaining sanitary conditions than the proper inspection of the dairy, whether furnishing milk for family use or for sale. It is the plain duty of every municipality and state to prohibit the sale of milk to its citizens from dairies which are not periodically and frequently subjected to the most rigid expert inspection. Such inspection would not only secure the health of the animals but tend directly toward the cleanliness of the dairy. Only by the exercise of unusual care is it possible to keep milk from becoming contaminated.

Preparation of Milk.—Every part of the animal, especially the udders, should be kept scrupulously clean by proper currying and washing. The milk should be collected in vessels with as small an orifice as possible. As soon as drawn the milk should be strained and artificially cooled to a temperature of at least 50 degrees F., if not lower. A convenient apparatus for cooling the milk is shown in Fig. 14. In this condition, without being exposed to infection and being protected at every point by closed vessels, stoppered when necessary by sterilized cotton, the milk is conducted into sterilized bottles and again stoppered with a sterilized cork of some description. The milk is kept cold until delivered to the consumer and should be kept cold by the consumer until used. By following these precautions it is possible to deliver a pure, wholesome, unpasteurized milk in a condition which remains practically unchanged for even a longer period than twenty-four hours.

Certified Milk.—Dairies which are inspected either by operation of the law or, voluntarily, by a competent body of medical and scientific experts duly authorized to make such inspection furnish to the market what is known as certified milk. Each bottle of this milk bears the stamp of certification and this stamp may be used from the time of one inspection until a certain date specified on the stamp when the next inspection takes place. The duty of the inspectors is to see that diseased animals are at once removed from the dairy, that the sanitary conditions of the stable are perfect, that the food is

FIG. 14.—APPARATUS FOR COOLING MILK.

abundant and wholesome, that the milking process is conducted according to the principles above outlined, and that the proper precautions are taken to prevent infection during the preparation of the milk for the market. The milk should be examined chemically and bacteriologically at each inspection, or oftener, to see that it is of a standard quality, both in respect of the number and character of the organisms which it contains and of its chemical constituents. Certified milk is, of course, more expensive than non-certified, inasmuch as the dairy is necessarily called upon to bear the expense of inspection. However, the superior quality of such milk and its certain freedom from infection more than offsets the increased price, and makes certified milk the ideal food of a milk character, not only in the family, but especially in the hospitals, orphan asylums and other public institutions. It seems quite certain that in the near future practically all the milk that is sold upon the market of the country will be of a certified quality.

Pasteurized Milk.—When milk is heated to a temperature of about 140 to 160 degrees the greater part of the living organisms contained therein are destroyed. At the same time the temperature is not high enough to give to the milk that peculiar taste which it acquires when boiled. Such pasteurized milk, placed in sterilized bottles, stoppered with sterilized stoppers and kept in a cool place, will keep many days and even weeks without apparent deterioration. Physicians and hygienists are quite agreed that pasteurized milk is not so wholesome, especially for children, as certified milk which has not been subjected to a heat sufficiently high to kill the organisms contained therein. The natural ferments of the milk, namely, the enzymes which produce the lactic fermentations, promote rather than interfere with the digestion of the product. The killing of the beneficial organisms of the milk is only justified when there is danger of pathological germs being present. Hence the pasteurization of milk must in this sense be regarded as a substitute for inspection and certification.

There may arise cases where pasteurizing even of certified milk may be desirable, namely, when from necessity it must be kept for a considerable period before use, as on shipboard, and other places inaccessible to a daily supply of fresh milk. Pasteurizing is also justifiable for miscellaneous milk supplies, the origin of which is unknown. It is safer, by far in this case, to pasteurize than take the chance of consuming pathological germs. (See also page 537.)

Pasteurizing of Milk.—A convenient method of pasteurizing milk is recommended by the Dairy Division of the Department of Agriculture, which is as follows:

*Directions for the Pasteurization of Milk.**—The pasteurization of milk for children, now quite extensively practiced in order to destroy the injurious germs which it may contain, can be satisfactorily accomplished with very simple apparatus. The vessel containing the milk, which may be the bottle from which it is to be used or any other suitable vessel, is placed inside of a larger vessel of metal, which contains water. If a bottle, it is plugged with absorbent cotton, if this is at hand, or in its absence other clean cotton will answer. A small fruit jar loosely covered may be used instead of a bottle. The requirements are simply that the interior vessel shall be raised about half an inch above the bottom of the other, and that the water shall reach nearly

*By Dr. De Schweinitz.

or quite as high as the milk. The apparatus is then heated on a range or stove until the water reaches a temperature of 155 degrees Fahrenheit, when it is removed from the heat and kept tightly covered for half an hour. The milk is rapidly cooled without removing it from its containers and kept in a cool place. It may be used any time within twenty-four hours. A temperature of 150 degrees maintained for half an hour is sufficient to destroy any germs likely to be present in the milk, in cold weather, or when it is known that the milk reaches the consumer soon after milking, and it is generally safe to adopt this limit. It is found in practice that raising the temperature to 155 degrees and then allowing the milk to stand in the heated water for half an hour insures the proper temperature for the required time. If the temperature is raised above 155 degrees the taste and quality of the milk will be affected.

Inasmuch as the milk furnished to consumers in large cities in summer contains at the time of delivery an immense number of miscellaneous bacteria, this procedure may not fully meet the requirements during hot weather, not only because such milk will not remain sweet for twenty-four hours unless kept in a good refrigerator, but also because the bacteria not destroyed by the heating may at times produce digestive disturbances in the very young. Under such circumstances it is best to keep the bottles in the water until it boils or to use one of the many steamers now on the market. After the bottles have been kept at the boiling point for three to five minutes (or longer if they are large) they should be cooled as promptly as possible and kept in a refrigerator until used.

The simplest plan is to take a tin pail and invert a perforated tin pie-plate in the bottom, or have made for it a removable false bottom perforated with holes and having legs half an inch high to allow circulation of the water. The milk-bottle is set on this false bottom, and sufficient water is put into the pail to reach the level of the surface of the milk in the bottle. A hole may be punched in the cover of the pail, a cork inserted, and a chemical thermometer put through the cork, so that the bulb dips into the water. The temperature can thus be watched without removing the cover. If preferred, an ordinary dairy thermometer* may be used and the temperature read from time to time by removing the lid. This is very easily arranged, and is just as satisfactory as the patented apparatus sold for the same purpose. Any other simple method of procedure will give the same result.

Average Content of Fat in American Milk.—From the thousands of analyses of American milks that have been made it appears that the average content of fat therein is about 3.90 percent. Of the different breeds of cows the Holsteins produce milk with the least content of fat and the Jerseys with the

*Before using the dairy thermometer it is best to have it tested, as it may be unreliable in the upper parts of the scale.

greatest. It is not unusual to find in the milk of a Jersey cow a content of 6 or 7 percent of fat.

Comparison of Cow's Milk with Other Varieties.—Human milk differs from milk chiefly in having a much lower content of casein and a higher content of milk sugar. Goat's milk has a higher content of casein than milk, somewhat higher content of fat, and slightly less sugar. Ewe's milk is very rich both in protein and fat. Mare's has a low casein and fat content and is exceptionally rich in sugar. Ass's milk has less casein and protein than milk but more sugar. For additional data relating to milk see chapter on infants' foods.

Cream.—When milk is allowed to stand for some hours in a cool place or when it is mechanically treated in a separator the fat particles, being of a lower specific gravity, are separated, and when they reach a certain degree of consistence they form a product known as cream. The quantity of fat in cream varies according to the method of separation. On standing for a period of about twelve hours in a cool place the separated cream may be removed by skimming and should contain at least 18 percent of milk fat. Under the action of the separator, cream of a much greater content of fat is usually produced, often reaching as much as 30 percent or more. The separation of cream mechanically in a separator is preferable to the method of time separation by gravity alone. The cream secured by the separator is very much fresher, as it can be removed as soon as the milk is drawn and cooled. Its content of butter fat can also be regulated to the desired amount and, in the third place, a more complete separation is secured than by gravity. By the proper manipulation of the separator almost all of the fat in milk is readily removed. Cream should be kept under the same conditions as has been described for sanitary milk. When placed in sterilized containers, properly stoppered and kept cool, fresh cream will keep sweet as long as milk under similar circumstances.

In large dairy industries the separator is practically the only method now employed for securing cream while for farm use the gravity method of standing in a cool place for twelve or twenty-four hours is the commonly practiced method.

Cream is used on the table with fruit and cereal foods and especially in beverages such as tea and coffee. It is also prescribed by physicians for certain diseases and derangement of the digestive organs where the nitrogen content of milk produces irritation and fails of digestion. Cream is not a complete food in the sense that milk is inasmuch as the other constituents of milk are less in proportion as the percentage of fat is increased, yet cream contains at least a part of all the food elements in milk, as, for example, nitrogenous constituents, principally casein, milk sugar, and mineral matters.

It must be remembered in this case that the fat is the variable element and as that is increased the proportion of other ingredients, necessarily, is diminished. The most important use of cream is in the manufacture of butter.

Standards of Cream.—The composition of cream varies with almost every sample. The standards for cream vary in different states and cities. The national standard requires 18 percent of fat.

Skimmed Milk.—The residue which is left from the removal of cream is known as skimmed milk. Skimmed milk contains the principle part of the nitrogenous constituents of milk, the greater quantity of its sugar and a very large quantity of its mineral matter. It is still a very valuable food product, lacking only the element of fat. When eaten with nuts or other oily food skimmed milk would complete the ration and make a well balanced food. The chief prejudice against skimmed milk is that it has been so often sold for whole milk. When sold and consumed under its own name it is not a fraudulent body and is deserving of a higher place in the dietary than has been ascribed to it. In the large creameries of the country the skimmed milk is usually fed to animals. It is one of the most highly esteemed foods for pigs and poultry, and is largely used for those purposes.

Composition of Skimmed Milk.—Naturally the composition of skimmed milk would be that of milk corrected for the abstraction of fat. It contains some little fat when prepared by the gravity method and only a very small portion when separated mechanically. The abstraction of the fat increases the relative proportions of sugar and casein.

Curd Test for Purity of Milk.—The Wisconsin curd test is conducted as follows: 1. Sterilize milk containers so as to destroy all bacteria in vessels. This step is very important, and can be done by heating cans in boiling water or steam for not less than one-half hour.

2. Place about one pint of milk in covered jar and heat to about 98 degrees F. (Figs. 15 and 16).

3. Add ten drops of standard rennet extract and mix thoroughly with the milk to quickly coagulate.

4. After coagulation, cut curd fine with case knife to facilitate separation of whey; leave curd in whey one-half hour to an hour; then drain off whey at frequent intervals until curd is well matted.

5. Incubate curd mass at 98 to 102 degrees F. by immersing jar in warm water. Keep jars covered to retain odors.

6. After 6 to 9 hours incubation, open jar and observe odor; examine curds by cutting the same with sharp knife and observe texture as to presence of pin holes or gas holes. Observe odor.

7. Very bad milks will betray presence of gas-producing bacteria by the spongy texture of the curd and will have an off flavor.

8. If more than one sample is tested at the same time, dip knife and thermometer in hot water each time before using.

Normal milk contains practically no organisms but the straight lactic acid bacteria. These germs produce no gas and no bad odors, but purely lactic acid, and the curd formed therefrom is such as is represented in Fig. 17.

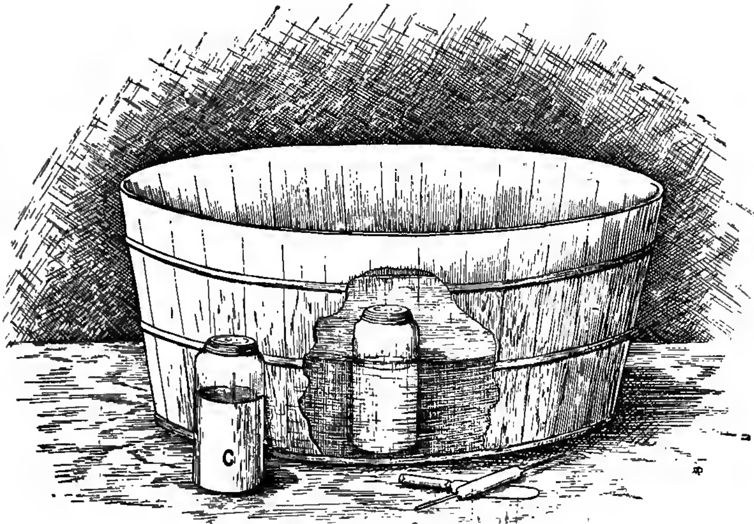


FIG. 15.—IMPROVISED WISCONSIN CURD TEST.
C, Can used to hold sample; P, pipette for measuring rennet; K, knife for breaking curd.

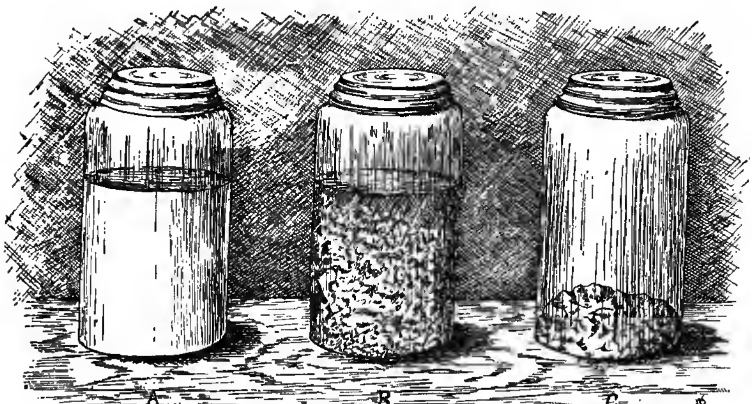


FIG. 16.—A, MILK; B. BROKEN CURD IN WHEY; C. MATTED CURD.

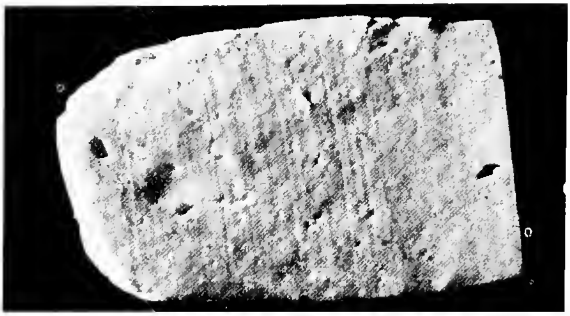


FIG. 17.—CURD FROM A GOOD MILK. LARGE, IRREGULAR HOLES MECHANICAL.

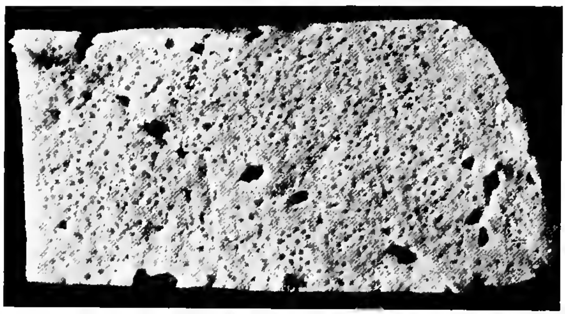


FIG. 18.—CURD FROM A TAINTED MILK. LARGE, IRREGULAR HOLES MECHANICAL; SMALL PIN-HOLES DUE TO GAS.

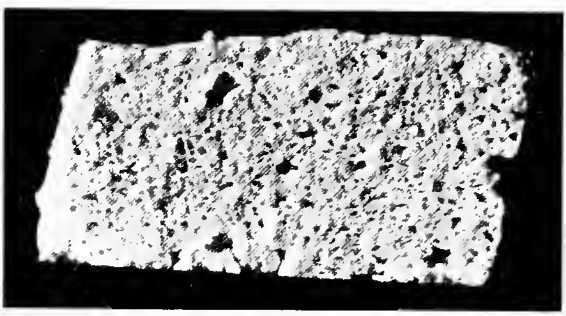


FIG. 19.—CURD FROM FOUL MILK.

Milk contaminated by the introduction of dust, dirt, fecal matter, or kept in imperfectly cleaned cans becomes fouled with gas-producing bacteria that break down the milk sugar and so produce gases and usually undesirable odors. . . Therefore milks showing the presence of gas or bad odors in any considerable degree are milks that have been more or less polluted with extraneous organisms or carelessly handled, and as a consequence such milks show a type of curd revealed in Figs. 17, 18, and 19.

Whey.—The residue left from milk in the process of the making of cheese is known as whey. Whey consists of that portion of milk which is not precipitated by the rennet and which separates when the casein of milk is coagulated and sets in the process of cheese making. The whey contains the principal portion of the water in milk, the most of the milk sugar therein, and small quantities of butter and soluble nitrogenous portions (albumin) and solid particles which remain suspended in the solution. It may, therefore, be properly considered as milk from which the greater part of the nitrogenous portions and fat particles has been separated. The value of whey as a food product consists chiefly in the milk sugar which it contains. It is not very largely used for human food but is valued as a food for young domesticated animals, especially pigs and poultry.

Composition of Whey.—The whey resulting from the manufacture of cheese contains nearly all the foods of the whole milk with the exception of the casein and fat. It is composed of from 6 to 8 percent of solids consisting chiefly of milk sugar, some albumin, a little fat, and about 0.6 percent of mineral matter.

Koumiss.—Koumiss originated in Asia Minor in the production of a fermented drink from mare's milk, which is richer in milk sugar than the lactic secretions of most other mammals. By the fermentation of the milk sugar mare's milk is converted into a fermented beverage containing a small percentage of alcohol. In this country koumiss is made almost exclusively from cow's milk and by special fermentation at a low temperature. It is a beverage valued especially by convalescents and invalids and frequently is capable of nourishing the body in diseases which affect the digestive organs when other foods fail of assimilation. It is also a cooling and delicious beverage for those in health when properly prepared and stored.

Modified Koumiss or Kephir.—Koumiss made from cow's milk with the previous addition of milk or cane sugar to increase the alcoholic content cannot be regarded as a natural product but rather one to which the term "modified" may be applied. The greater part of koumiss made in the United States from cow's milk is of this modified variety. Cow's milk contains on an average about 4 or 5 percent of sugar and does not yield a fermented beverage of a sufficient alcoholic content without reducing the actual sugar content of the beverage below the point of palatability. Cane sugar is usually employed as the modifying agent. While modified koumiss cannot be regarded as of equal value with the natural article made from mare's milk it is a palatable and wholesome beverage when produced and stored under proper conditions. The quantity of alcohol produced in any case is not very great and the change in composition which renders koumiss so easily assimilable in many cases cannot be due alone to the alcohol formed but to the fermentative changes produced by enzymic action which takes place in the other constituents of koumiss, especially casein during the process of fermentation.

Koumiss or kephir, which is the name applied to koumiss made from cow's milk, is also prepared with the addition of honey, in the place of sugar, and small quantities of wheat flour, not exceeding 20 parts to 1500 parts of othei constituents. Koumiss is sometimes artificially fortified by the addition of small quantities of alcohol, but this practice must be regarded as extremely reprehensible. The alcohol of koumiss is incidental to its fermentation and should not be increased beyond the normal amount. One of the important points in the making of koumiss is the control of the temperature which, during fermentation, ought not to rise above 50 degrees in order to get the best results. Koumiss may be made in the bottle in which it is kept, in fact, it is best made so, and its fermentation then resembles that of champagne. During the process of fermentation the bottle should be shaken at least once a day in order that the part which coagulates cannot be unevenly distributed throughout the mass. The bottle should be strong enough to resist the pressure produced by the carbon dioxid which is formed and the cork should be securely tied in. As in the case of champagne it is best to place the bottle with the cork down. Before using, the bottle containing the koumiss should be well shaken in order to thoroughly mix the contents which form a creamy, foamy mass extremely palatable, highly nutritious, and valuable not only as a beverage but in many cases of disease and disordered digestion as a food. In fact the value of koumiss for medicinal purposes, that is for medicinai food, is not thoroughly appreciated by the medical profession. This may be due to the fact that the art of making koumiss is not generally known, and while the general principles upon which its manufacture is based have been set forth it requires an expert to make a palatable and useful article ("British Dairy Farming" by Jas. Long). It is worthy of suggestion now that the use of horses for draft purposes has practically been superseded by the automobile and the trolley that the production of real koumiss from mare's milk might become a very useful field of industry in the United States. It is perfectly certain that the genuine article must possess properties whicli are not wholly found in the imitations of koumiss which are so common in this country. It is well understood by physicians that a natural product produced from natural material is always superior in character both as a food and medicine to the synthetic or artificial product. Whenever, therefore, a fermented beverage produced from natural sources is contaminated by artificial products the resulting compound is not so useful nor digestible. For instance, wine which is made partially from sugar and beer made partially from dextrose, although they may be healthful and wholesome beverages, are inferior in quality and character to the real product made from grape juice or barley malt.

Buttermilk.—The residue left in the churn in the manufacture of butter is termed buttermilk. There are two distinct varieties of buttermilk, namely that resulting from the churning of unsoured cream and that remaining from the churning of soured and ripened cream. The first kind of buttermilk does not differ in its characteristic essentials from skimmed milk and therefore is not considered here. The second class of buttermilk is far more common and is a beverage of pleasing acid taste. When made from properly ripened cream it is wholesome and delicious, especially in summer time. Buttermilk usually contains small particles of butter which have escaped aggregation during the final process of churning. In well prepared buttermilk, however, these particles of butter are not very numerous and they add nothing to the palatability, although they do add something to the nutritive properties of the beverage. It does not differ greatly, therefore, in its chemical properties from skimmed milk, although there is a slight difference in the relative percentages of the milk solids in cream as compared with the same constituents in whole milk. The composition of buttermilk is shown in the following table:

COMPOSITION OF BUTTERMILK.

	From Sweet Cream. Percent.	From Sour Cream. Percent.
Water	89.74	90.93
Fat	1.21	0.31
Milk sugar	4.98	4.58
Protein	3.28	3.37
Ash	0.79	0.81
Acidity	....	0.80

There is another beverage sold under the name of buttermilk which is produced by the artificial souring of skimmed milk with the aid of appropriate ferments, chiefly those producing lactic acid. This preparation is simply artificially soured skim milk, and has no claim whatever to the name buttermilk.

Bonnyclabber.—Bonnyclabber is a term applied to milk which has become soured by lactic fermentation, producing a gelatinous coagulation of casein which is sufficiently firm at times to prevent the liquid from being poured. Clabber may be regarded as a natural cheese curd except that the fat is chiefly on top. It is a beverage or food of a very agreeable taste to most persons and is often eaten with sugar. In the summer it is often formed during hot murky weather, especially of that character which produces thunder storms. For this reason it is a common supposition that thunder or lightning sours milk. The thunder and lightning, however, have nothing to do with this process. The condition of the atmosphere which produces an environment favorable to electrical disturbances of this kind also favors in the highest degree the growth of the organisms which produce the lactic ferments. Hence thunder storms and the rapid souring of milk are frequently coincident leading to the popular impression as above mentioned. Inasmuch as the souring of milk usually takes place after the cream has risen the composition of clabber is practically that of skimmed milk modified by the lactic fermentation which has taken place.

BUTTER.

When cream, especially cream in which incipient lactic fermentation has been set up, is subjected to agitation in a churn under proper conditions of temperature the particles of butter therein contained are collected into masses so that the butter can be separated from the residual liquid. This process is technically called churning. The domestic churn in its simplest form is perhaps well known to almost everyone, especially those who have lived in the country. In the domestic manufacture of butter the cream is collected and set aside until sour, that is, until lactic fermentation has set up. When this is sufficiently advanced the cream is placed in a churn, the simplest form of which is a wooden, cylindrical vessel of appropriate size, being much longer than its horizontal diameter. The churn is provided with a dasher, namely a perforated wooden disk with a handle which passes through a hole in the cover. When the churn is charged the butter is produced by agitation with the dasher. In winter time warm water is added to the mixture in order to raise the temperature to the proper gathering point of butter, namely 65 to 70 degrees F. For the same reason cold water is added in the summer time. The art of the dairy maid is shown in the proper regulation of the temperature to secure the best results. When the cream is properly ripened and the temperature is suitable the gathering of butter will be accomplished in from twelve to thirty minutes. In unfavorable conditions the duration of churning may be for a much longer period.

In dairies and large establishments churning is accomplished by machinery with very different mechanical appliances, but the principle which underlies the process is the same as that outlined above. The accompanying figures illustrate the process of churning by mechanical means in a modern dairy (Figs. 20 and 21).

Treatment of Butter.—The crude butter secured by churning is subjected to washing and seasoning processes in order to prepare it for the market. The washing or working of butter is accomplished by means of water. The object of this "working" is to separate from the crude butter as much of the curd and other non-fatty constituents of the cream as can be conveniently removed. The removal of these particles not only makes a butter of a higher grade but also one of better keeping properties. The working of butter also has much to do with its grain or texture, which is one of the characteristics to which special attention must be paid. The best grade of butter is that which receives no treatment other than the washing and working process to which attention has been called. This kind of butter is known as natural

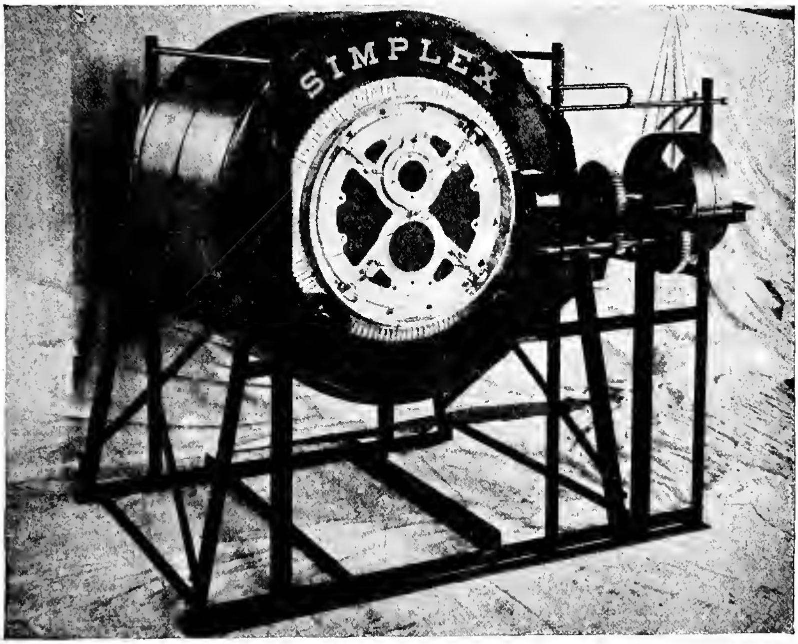


FIG. 20.—POWER CHURN READY FOR USE.—(*Courtesy of the Bureau of Animal Industry.*)

or unsalted or uncolored butter, that is, a fresh, sweet product of an agreeable aroma, palatable, of fine texture and grain, and is the best product of its kind for human consumption. It also brings the highest price on the market and, by reason of its method of preparation, the consumer can usually be assured that it is fresh in character.

Salting Butter.—In the United States, especially, consumers of butter generally require that it shall be salted. For this purpose fine grades of dairy salt are used as free as possible from impurities and consisting of fine particles or crystals which rapidly dissolve in the residual moisture of butter.

This promotes a uniform distribution of the salt in the form of brine throughout the mass of butter. The existence in butter of undissolved particles of salt is highly prejudicial to its taste and character. The quantity of salt used in butter is determined by the taste of the consumer. The more salt the butter contains the less value it has as butter and hence the quantity should be limited to the smallest possible amount demanded by the consumer's taste. Often butters are found in commerce which are so full of salt as to be wholly unpalatable and there is a tendency on the part of the greedy manufacturer to add excessive quantities of salt because it is very much cheaper than the

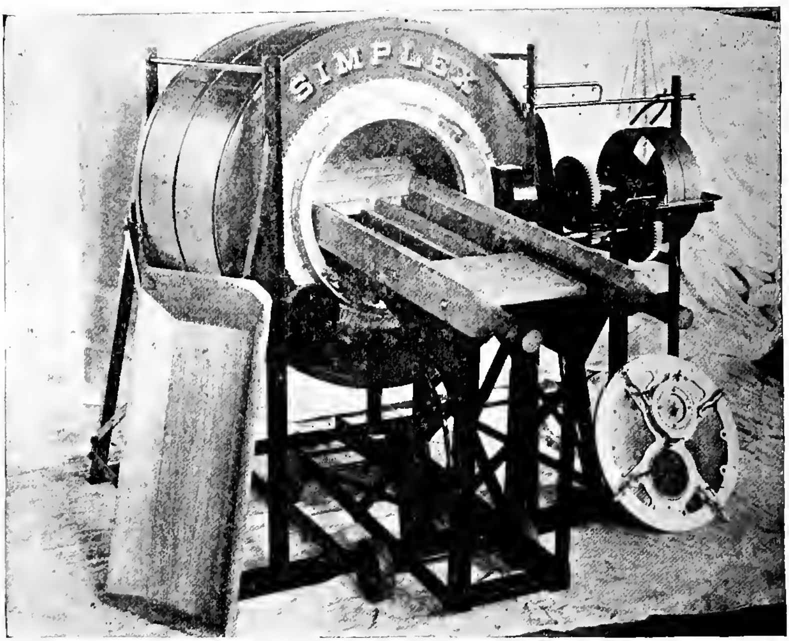


FIG. 21.—POWER CHURN, OPEN.—(*Courtesy of the Bureau of Animal Industry.*)

butter itself and thus he hopes to add to the profit of the industry. On the contrary this practice usually results in loss, since such highly salted butter naturally brings the lowest price. The amount of salt which is used in butter should not exceed two percent.

It is a common supposition that salt in butter is a preservative. This is true when used in large quantities, that is, in quantities which render the butter somewhat unpalatable. The very small quantity of salt used purely for condimental purposes cannot be regarded as aiding in any material way the preservation of the product.

Coloring Butter.—Unfortunately the practice of artificially coloring butter is very prevalent in the United States. Practically all the butter found upon the market, even in the spring and summer, is more or less artificially colored, often with coal tar (anilin) dyes which, to say the least harm of them possible, are open to suspicion in respect of wholesomeness. The practice of coloring butter produced in winter may be regarded as universal, though none the less reprehensible on that account. The object of coloring butter is, undoubtedly, to make it appear in the eyes of the consumer better than it really is, and to this extent can only be regarded as an attempt to deceive. If cows are properly fed during the winter months with wholesome, nutritious food to which a small proportion of roots such as carrots or ruta bagas are added or with yellow maize and clover hay, even in winter time the butter produced will have an attractive light amber tint which appeals strongly to the æsthetic sense of the consumer. The natural tint of butter is as much more attractive than the artificial as any natural color is superior to the artificial. There is the same difference between the natural tint of butter and the artificial as there is between the natural rose of the cheek and its painted substitute. It is claimed, and perhaps justly, that the use of certain vegetable colors, such as annotto, does not introduce any unwholesome substance into the product. Admitting this, we must next ask whether it deceives the consumer. If so, it is difficult to understand upon what ethical principal any plea for the artificial coloring of butter can rest. If it is admitted that there is no valid reason why butter should be colored other than the artificial coloring of foods in general, which is a practice so reprehensible that it is almost universally denounced, its practice cannot be easily defended. The dairymen of our country are honest and honorable and evidently do not clearly see the false position in which the practice of coloring butter puts them. When the dairymen of our country understand that the naturally colored products will bring the highest price on the market and appeal more strongly to the confidence of the consumer it is believed the artificial coloring in butter will be relegated to the scrap pile of useless processes. It cannot be claimed in any sense that coloring of butter artificially ever adds anything to its value as a nutritive substance.

One of the claims for justifying the coloring of butter is that it distinguishes it from oleomargarine. This, however, is not the case since, under the law, oleomargarine may be colored upon the payment of a tax of ten cents per pound. The consumer has at his disposition a complete protection against fraud in the use of oleomargarine by the operation of state and federal laws, irrespective of the tint of the product. Oleomargarine and butter are distinguished from each other by their natural colors and also by their chemical and physical properties and, therefore, there can be no justification for the coloring of butter on the plea that it distinguishes it from oleomargarine.

Thus, from every point of view it is evident that the artificial coloring of butter is undesirable. It interferes with the right of the consumer, who should know the exact character of the product he buys, and it stands in the way of the prosperity of the manufacturer by keeping upon the market a cheaper product which tends to decrease the price even of that of better quality.

Standard Butter.—According to the standard established by authority of Congress butter must not contain more than 16 percent of water and not less than 82.5 percent of butter fat.

Renovated Butter.—The law of Congress which controls the manufacture of renovated butter is executed jointly by the Treasury and Agricultural Departments. The quantity of renovated butter produced during the year ending June 30, 1905, was 60,290,421 pounds.

Adulterated Butter.—The quantity of adulterated butter which was produced under the authority of the Act regulating the manufacture of oleomargarine and butter and on which is laid a tax of 10 cents per pound during the fiscal year ending June 30, 1905, was 3,671 pounds. These data show that the tax of 10 cents per pound laid upon adulterated butter has practically destroyed the manufacture of that article. Normal butter has from 12 to 14 percent of water. It is sometimes rechurned with water to raise the water content to 16 percent. Such a practice results in adulteration whether the content of water exceeds 16 percent or not.

Influence of Food upon Butter.—The character of butter is very easily affected by the nature of the food consumed by the cow. Butter has the faculty of absorbing very readily odors of all kinds. Foods, therefore, which have characteristic odors impart them to the butter. A most striking instance of this is in the eating of wild garlic. In this case both the milk and the butter are affected to such a degree as to be in many cases unpalatable. Hence foods or substances in foods which are aromatic or odoriferous are likely to impart their peculiar odor to the milk, cream, and butter. Of all the constituents of milk the fat appears to have the highest faculty of absorbing these objectionable odors. Therefore, the feeding of distillery slops is also apt to impart an unpleasant odor to milk and butter, whereas if these slops be dried and their volatile aromatic principle expelled, but little trouble is experienced in their use. The physical characteristics of butter are also changed in a marked degree by the character of the food. Butter fat, as has already been indicated, is distinguished from other animal fats by its content of soluble and volatile acids of which butyric is the chief. There are certain kinds of foods which decrease or tend to decrease the content of butyric acid in butter.

Influence on Melting Point.—The character of the food also has a marked influence upon the melting point of butter. The author showed many years ago that the use of cottonseed meal as food for cows tends to raise the melting point of butter. This was regarded as an index of some value for the southern portion of the country, where a high temperature obtains over a period of six or seven months of the year. If the melting point of butter, which when normal is about 33 degrees C. (91° F.), could be increased to 35 or 36 degrees C. (95° F.), it would be of immense advantage in these warm climates and, in fact, in all parts of the country during the months of July, August, and September. There is no apparent tendency to increase the melting point of butter by feeding other oil cakes.

Transmission of Other Principles in the Food to the Butter.—Experience has shown that when cows are fed cottonseed meal or its products the quality of cottonseed oil which responds to the color test known as the Halphen test, namely, the production of a red color with carbon disulfid and amyl alcohol, is transmitted also to the butter. In some cases this reaction is extremely faint while in others it is displayed with an intensity which is claimed by some to be equal to that of the admixture of 5 percent of cottonseed oil with the butter. The use of cottonseed meal, on the contrary, does not seem to notably affect either the content of volatile acid in the butter or its refractometer reading. (Experimental Station Record, Volume 25, page 716.)

OLEOMARGARINE.

Oleomargarine is the name applied to any fatty substance which is prepared to be used in the same manner as butter. Oleomargarine is defined by Act of Congress as follows:

An Act defining butter, also imposing a tax upon and regulating the manufacture, sale, importation, and exportation of oleomargarine. (Approved August 2, 1886.)

"That for the purposes of this act certain manufactured substances, certain extracts, and certain mixtures and compounds, including such mixtures and compounds with butter, shall be known and designated as "oleomargarine," namely: All substances heretofore known as oleomargarine, oleo, oleomargarine oil, butterine, lardine, suine, and neutral; all mixtures and compounds of oleomargarine, oleo, oleomargarine oil, butterine, lardine, suine, and neutral; all lard extracts and tallow extracts; and all mixtures and compounds of tallow, beef fat, suet, lard, lard oil, vegetable oil, annotto, and other coloring matter, intestinal fat, and offal fat made in imitation or semblance of butter, or, when so made, calculated or intended to be sold as butter or for butter."

The manufacture of oleomargarine can only take place in the United States under the supervision of officials of the Internal Revenue. All oleomargarine which is artificially colored a yellow or yellowish tint in semblance of natural butter pays an internal revenue tax of 10 cents per pound. Oleomargarine uncolored pays a revenue tax of one-fourth cent per pound. Oleomargarine when made under proper sanitary conditions from sanitary raw materials is a wholesome and nutritious article of diet and usually can be sold at a smaller price than butter. It is especially a food product which commends itself to those who are under the necessity of practising strict economy in the cost of food in the family. The principal objection, and in fact the only valid objection, to its use is found in the frauds which have been committed in its manufacture and sale. There has been a constant disposition on the part of dishonest manufacturers and dealers, since the time when oleomargarine became a commercial commodity, to sell it as butter. Although the penalties of national and state laws are very severe in this respect the practice is continued. The opportunity for gain is so great that the cupidity of the manufacturer overcomes his fear of punishment and disgrace. With a more rigid national and state inspection, it is reasonable to hope that this fraudulent use of oleomargarine can be avoided and the pure, unadulterated article under its own name be supplied to those who prefer it either on account of its properties or its price.

Materials Used in the Manufacture of Oleomargarine.—*Neutral Lard.*—One of the principal basic components of oleomargarine is neutral lard or lard stearin, the properties of which have already been described. Beef fat stearin is another basic ingredient of oleomargarine and is the stearin derived from tallow or tallow itself. Beef fat has a higher melting point than lard and beef fat stearin a still higher melting point than the tallow. Hence it forms an ideal ingredient with which to mix the oily components which enter so largely into the manufacture of oleomargarine. The beef fat or beef fat stearin is easily distinguished by means of the microscope. It forms beautiful radiated fan-like crystals, the characteristic appearance of which is shown in Fig. 9, page 67.

Cottonseed Oil and Cottonseed Oil Stearin.—These are also important ingredients of oleomargarine affording the oily or more liquid constituents which, when mixed with the lard and stearin above mentioned, form a compound the melting point of which is slightly above that of butter and sufficient to maintain it in an unmelted state even in warm weather. The quantities in which these different ingredients are used vary greatly in different manufacturing establishments and depend largely upon the location where the oleomargarine is to be used. When manufactured for tropical or subtropical regions larger quantities of stearin are employed than when used in temperate zones or for winter consumption, in which case larger quantities of cottonseed oil and cottonseed oil stearin are employed with the mixture. After the fats are mixed it is usually the practice to churn them with milk in order to give a flavor of butter to the product. In some cases the yolk of eggs is mixed with oleomargarine, as it is claimed that they impart thereto a firmer and more homogeneous structure which renders the mass better, especially for cooking purposes. All the ingredients which are used in the manufacture of oleomargarine are made known and recorded in the books of the Commissioner of Internal Revenue and thus it is a product which it may be said is strictly under government supervision.

Description of Process of Manufacture.—The fat is taken from the cattle in the process of slaughtering, and after thorough washing is placed in a bath of clean, cold water, and surrounded with ice, where it is allowed to remain until all animal heat has been removed. It is then cut into small pieces by machinery and cooked at a temperature of about 150 degrees until the fat, in liquid form, has separated from the fibrine or tissue, then settled until it is perfectly clear. Then it is drawn into graining vats and allowed to stand a day, when it is ready for the presses. The pressing extracts the stearin, leaving the remaining product, which is commercially known as oleo oil, which, when churned with cream or milk or both and with or without a proportion of creamery butter, the whole being properly salted, gives the well-known food-product, oleomargarine.

Adulteration of Oleomargarine.—Since the coloring of oleomargarine is permitted upon the payment of a tax, oleomargarine which is colored cannot be said to be adulterated when the tax has been paid, although if coloring were not a legalized operation it would be an adulteration. Yellow oleomargarine is an imitation of natural butter and its manufacture should be prohibited unless the product is marked "imitation." The character of the coloring materials used is not prescribed by the Commissioner of Internal Revenue but as a rule the coal tar dyes are preferred in the coloring of oleomargarine to the vegetable coloring matter such as annotto and saffron. The remarks which have been made in connection with the use of poisonous materials in other products apply to oleomargarine.

Adulteration with Egg Yolks.—An adulteration which has been practiced in this country is the admixture of preserved egg yolks. Usually these yolks are secured in China, broken, and placed in vessels and preserved with borax or boric acid or salt. These eggs are generally collected during the early spring and summer months and are not sent to the United States until the fall or winter. The importation of such articles is now prohibited under the food laws of the country so that the adulterations with the imported article is no longer to be feared. It is possible to preserve domestic eggs in the same way, and the use of them in this manner is regarded as an adulteration, since such preserved egg products cannot be regarded as suitable for human food.

Adulteration with Preservatives.—Fortunately preservatives are not used to any extent in the manufacture of oleomargarine when intended for domestic use. The most suitable preservative in such a case as this would be borax or boric acid. It is not believed that these preservatives are used to any extent when the product is intended for domestic consumption. Whether or not preservatives are used in the product sent abroad I am unable to say.

Production of Oleomargarine.—According to the report of the Commissioner of Internal Revenue the quantity of oleomargarine taxed at 10 cents a pound produced in the United States for the fiscal year ending June 30, 1905, was 5,584,684 pounds, and for 1910, 3,491,978 pounds. The quantity produced in 1910 taxed at one-fourth cent a pound was 85,164,655 pounds.

COMPOSITION OF OLEOMARGARINE.

Specific Gravity at 40° C.	Water.	Insoluble Acid.	Sol. Acid by Washing Out.	Sol. Acid by Distillation.	Salt.	Albuminoids.
.90490	9.34	93.59	0.12	0.25	3.64	0.35

From the above data it is seen that the objections to the use of oleomargarine are more on the grounds of fraud and deception than in regard to nutritive and dietetic value. The components used in the manufacture of oleomargarine, when properly made, are all wholesome and digestible materials such as are consumed in eating various food products. It does not appear, therefore, that any valid objection can be made against the use of oleomargarine from from a physiological or hygienic standpoint.

CHEESE.

Historical.—The preparation of cheese is one of the oldest of the technical processes. It appears that it was known during the time of King David, at least a thousand years before Christ, and the Greeks were acquainted with it before the writings of Homer. Aristotle and Hippocrates describe the curdling of milk which at that time appears to have been accomplished by the use of the juice of the fig. The use of cheese was very common in Rome in the earlier historical days but the most of it was imported from the North. Cæsar speaks of the preparation of cheese among the German tribes. Cheese must, therefore, be regarded as one of the very oldest forms of prepared food used by man. It probably is almost, if not quite, as old as wine. These historical facts are interesting in showing how from the earliest times man has made use of the natural ferments to prepare food from the raw material. Attention must be called in this connection to the fact that many people claim that such foods as these are not natural foods but wholly artificial. The fallacy of such a claim is not difficult to show. An artificial food is one which is prepared out of materials which, themselves, are not edible food products or, at least, are not digestible or of a character which does not naturally occur by ordinary processes. Artificial foods, therefore, are purely synthetic, that is, made up from the elemental substances, or they are mixtures or compounds. On the contrary a food like cheese or wine is not a mixture or compound but a natural product from materials which themselves are food products. Milk is the raw material of cheese as the must of the grape is of wine. Both milk and must are rich and nutritious foods. The changes which each undergoes are in many respects the same. The must of wine undergoes an alcoholic fermentation and the milk sugar of cheese is subjected to a lactic fermentation and its casein to a proteolytic change which materially alters its character.

Cheese products are a very important part of food materials of the dairy. The term cheese is applied to the solid product produced from milk by coagulation of the casein with rennet or lactic acid and subjecting the solid product thus produced to a process of fermentation and ripening by the addition of appropriate seed material, seasoning, and storage at convenient temperature for varying periods of time. In the precipitation of the casein of milk the fat particles become mechanically entangled and form a part of the precipitate. There is a certain quantity of other milk constituents incorporated in the form of water, milk sugar, and mineral matter in the precipitated mass. The greater part of the other bodies which the milk contains, consisting of the milk sugar and a considerable portion of the soluble mineral matter, are separated in the form of whey. The composition of fresh cheese is that of that part of the milk which is precipitated and which is entangled mechanically in the precipitated matter. The ripened cheese is changed in its chemical constituents mostly as the result of fermentative action upon its nitrogenous constituents, that is, the casein, albumin, etc., contained therein. The ferments tend to change the casein into a more soluble form of protein, while at the same time they develop a flavor and aroma in a way agreeable to the nostril and palate. Various forms of moulds and other organisms grow on and in cheeses which influence their palatability and character. The final product of the ripened cheese varies not only with the nature of the original material as determined by the milk itself but with the character of the preparation and the nature of the organisms and ferments which are active during the ripening period, and also with the time and temperature of storage.

Kinds of Cheese.—It is not necessary and perhaps it would be impossible to attempt an enumeration of all the various kinds of cheese which are offered on the market. The first classification of cheese depends upon the character of the milk used. The term "cheese" in this country naturally refers to a product made from cow's milk since that is the principal milk used in the United States for cheese making. The term is used in this manual in that sense and when there is no qualifying word employed it is always understood that the product in question is made from the cow's milk. This implies that the milk is at least a standard milk, that is, a whole milk, unskimmed and containing not less than 3.25 percent of butter fat. According to the definition fixed by the Congress of the United States the term cheese is applied not only to this product but also to one containing a larger percentage of fat than this. The term cheese applies both to cheese made from milk and cheese made partially from milk and partially from cream. The term "full cream cheese" is also often used in the trade but is likely to be misleading and deceptive. The real significance of the term full cream cheese is that it is made of whole milk or milk unskimmed which contains its full complement of cream. The term "cream cheese" is also often used to indicate a cheese made partially of milk and cream. It is evident that the term cream cheese in this sense is misleading, since it can be properly applied only to a cheese made from cream alone. Such cheeses are made but, inasmuch as cream must have not less than 18 percent of fat in order to be called cream according to the United States standard, the cheeses made from such a source are too oily and fatty for ordinary consumption.

Cheese Made from Goat's Milk.—Goat's milk is also frequently used in making cheese. It is extensively employed in France and Switzerland for cheese making and also in other parts of Europe, and to a limited extent in this country. Some of the varieties of cheese which are most highly prized are made from goat's milk, such as Roquefort.

Adulteration and Misbranding of Cheese.—The most common form of adulteration or sophistication of cheese is the misbranding thereof in respect of the country where made or in respect of character. This is a form of deception which has long been established in the trade and one which cannot be condoned or excused. There are certain varieties of cheese whose names should be respected and in fact, in the case of all varieties that have an established character and reputation, their name should not be applied to other articles made in imitation thereof. In this country there is a national law which prohibits the marking of a food or dairy product falsely as to the state or territory where made. For instance, a cheese made in Ohio cannot be marked New York cheese and peaches grown in Delaware cannot be marked California peaches, maple sirup made in Indiana cannot be labeled Vermont maple sirup, etc. The ethical principle underlying this law is one which will meet the approbation of every well meaning man and therefore the extending of this principle to other forms of misbranding is an easy step. If it is a violation of the law to mark a cheese made in Ohio as made in New York it is certainly a violation of the ethical principle underlying that law to name a cheese made in Connecticut, Camembert. Unhappily, however, there are cheeses made in the United States to which foreign names are given, the universal excuse being that they are cheeses of the same type. In many cases this excuse is not a valid one and in no case is it an accepted one. To name a cheese made from cow's milk the same as that made from ewe's milk is a distinct misbranding in every sense of the term. There should be no difficulty in established varieties of cheese made in this country having names which are not deceptive and not intended to mislead the consumer as to the state, territory, or country where made. In one sense all cheese may be said to be of the same type, but because the taste and odor of a cheese made in the United States imitates to some extent that of a cheese made in France is no excuse for giving the French name to the American product. A further illustration of this principle is found in the following: The term Roquefort, for instance, is not properly applied to any cheese product except that which is made at or in the vicinity of Roquefort. In no other part of France can cheese be made bearing the name of Roquefort. The use of the term Roquefort, therefore, in any way upon American cheese is a misbranding and an attempt to deceive which usually is successful. There is not so great an objection to the term Swiss cheese as to Roquefort, but there is the same kind of an objection. The cheese which bears the name of Schweitzer-Käse is very extensively manufactured in Germany and sold under that name. A similar cheese is also extensively made in this country and sold under the name of Schweitzer-Käse. In this case there is no particular location or place which originated the name and has the sole right to use the name Swiss cheese. It is the name of a whole country and not of a location, and yet it is evident that Swiss cheese properly can only be made in Switzerland and not in Germany or in the United States. Any hard, tough cheese in which a large number of holes is found and which on cutting makes a flexible, semi-leathery slice has to a certain extent the appearance and perhaps the taste and flavor of genuine Swiss cheese.

It should not be difficult to find a market for all good cheese made in this country, under appropriate American names indicating their origin. If the term Swiss cheese is at all allowable on a package it should be placed as a minor part of the label and with the statement that it is of that type. Even this transgression is perhaps difficult of excuse.

Artificial Coloring.—Next to misbranding and misnaming of cheeses, perhaps the most common adulteration is that of artificial coloring. The public taste has been led in the matter of cheeses, especially of American origin, to look for a deep yellow color. This is also associated with the idea of the use of a large quantity of rich, naturally yellow-colored cream. The addition of an artificial color to a cheese never adds anything to its value, and to the really æsthetic eye detracts much from its appearance. The presence of this rich artificial tint is calculated in many instances to excite a suspicion in regard to the character of the cheese and thus interferes with its proper gustation. There is another more serious objection than the one just mentioned, namely, that it is possible from skimmed milk to make a highly colored cheese which would appear to the consumer to be made of whole milk or of milk and cream, and thus a deliberate deception is perpetrated. The consumer of cheese should demand that artificial coloring of all kinds be omitted from cheese products.

Moreover, these colors may of themselves be deleterious in character and if so they are forbidden by law. By reason of the generally deleterious qualities of coal-tar dyes they should be rigidly excluded from cheese. There is a growing demand in the United States for uncolored dairy products. The coal tar dyes are cheaper and produce faster and more natural looking tints than the vegetable colors such as annotto and saffron, and hence, until prohibited by law, they were almost universally employed. All of these dyes in a concentrated form are highly poisonous and injurious and several instances are on record of death, especially in the case of young children, from eating concentrated colors. The fact that a poison of this kind is diluted by the cheese is no excuse for its use. The only protection which the consumer has, which is reliable in all cases, is the prohibition of coloring matter in cheese.

By Act of Congress of June 6, 1896, coloring matter is permitted to be used in cheese in the United States and doubtless it will continue to be used under this authority until that portion of the Act is repealed or until the consumer demands an uncolored article. The pure, natural color of the cheese is universally acknowledged to be best, most palatable, and most desirable.

Preservatives.—Fortunately there is little to be said in regard to preservatives in cheese because they are almost unknown. The addition of a preservative to a cheese at the time of its production would so seriously interfere with the ripening process as to defeat the purpose of storage altogether. Hence in so far as preservatives are concerned there is little danger of adulteration.

Impure Raw Materials.—If cheese be made of pure, wholesome material, no inspection of factories is necessary. But it is entirely possible through carelessness, ignorance, or design to use in the making of cheese milk which may itself be infected. Cheese made from such milk of course would carry the infection of the milk. This is a sort of adulteration which can only be excluded by careful sanitary inspection of cheese factories. Such an inspection has already been partially instituted by federal, state and municipal authorities.

Filled Cheese.—Formerly there was a very considerable adulteration of cheese by manufacturing it from skimmed milk and supplying from an artificial source the necessary fat. Cottonseed oil, lard, and other edible oils are used for this purpose.

Composition of Filled Cheese (Circular No. 11, Bureau of Animal Industry).—Neutral lard is the principal fat which is substituted for milk fat in filled cheese. It is used to the extent of two or three pounds for every 100 pounds of skimmed milk. The principal objection to a filled cheese is not on account of its containing lard, which in itself is not unwholesome. But lard is an entirely different fat from milk fat, and differs in the character of the fermentation which takes place. The characteristic flavors and odors which are contributed by the milk fat in the cheese are entirely wanting, and the cheese is devoid of aroma and flavor and is nothing more than a mixture of casein with lard. Filled cheese is such a poor imitation of the genuine article that it can never have any very great vogue, and especially under the present law which requires it to be labeled and the payment of a tax.

A filled cheese which is on the market not properly stamped and duty paid in harmony with this act of Congress is adulterated, and they who make and sell it are amenable to the law. The annual report of the Commissioner of Internal Revenue for the year ending June 30, 1910, shows that receipts of $2,847.33 were obtained by the tax on filled cheese during that year. The amount made is, therefore, insignificant from a commercial point of view.

From the above data it is seen that the manufacture and sale of filled cheese in the United States is almost a thing of the past and this form of adulteration, assuming that the law is thoroughly executed, is not now likely to be often met with.

Cottage Cheese.—Cottage cheese is a term applied to a product which is usually only a raw material of cheese. It is the fresh, precipitated, and unripe milk product, above described as used in cheese making. It is a highly nutritious and very palatable product, usually prepared at home and not suitable for keeping or transportation. It is often made from sour milk in which the casein is coagulated by the natural development of lactic acid. The sour milk is placed in a cloth bag and the whey allowed to escape by gravitation. The final portion of the whey may be forced out by pressure. The residue, when properly seasoned with salt or in any way to suit the taste of the consumer, is very palatable. Cream is often added to this residue which increases the normal amount of fat which it contains.

COMPARATIVE COMPOSITION OF AMERICAN AND EDAM CHEESE.

The chemical composition of some of the principal varieties of cheese are shown in the following table:

	WATER. Percent.	ASH. Percent.	FAT. Percent.	PROTEIN. Percent.
American cheese,	27.5	4.1	32.5	28.38
Edam cheese,	36.34	4.24	31.17	22.28

The data show that cheese is essentially a nitrogenous and fat food, containing only small quantities of carbohydrates, and therefore it is not a complete ration. It is a ration, however, which is complementary to a highly starchy diet such as rice or maize bread or potatoes. Bread and cheese or potatoes and cheese or rice and cheese, therefore, make a well balanced diet, highly nutritious, easily digestible, and quite palatable.

Manufacture of American Cheeses.—The large cheeses which are principally found upon the American market may be said, in general, to resemble the Cheddar type, although the calling of these cheeses by the name "Cheddar" is misleading, and to that extent a misbranding of the product.

There are two common methods of making these cheeses which are in vogue in the United States, namely, the "stirred curd" or "granular" method and, second, the Cheddar method. (Bulletin 104, Department of Agriculture of Pennsylvania, 1902.) The latter is the one more extensively used. The second product does not differ essentially in character from the first, though the latter method, it is claimed, gives a more solid cheese and one of more uniform character and with a slightly less content of moisture. Since the Cheddar method has practically come into sole use, displacing the first method, a description of the Cheddar method alone will be sufficient to illustrate the method of making large cheeses which are now so common on the American market and which have such a well merited reputation. The process is divided into eight parts: First, coagulating the milk; second, cutting the curd; third, heating the curd; fourth, removing the whey; fifth, cheddaring the curd; sixth, milling the curd; seventh, salting and pressing the curd; eighth, curing the cheese.

Rennet.—As has been said in the description of cheese making, the material which is most useful in the precipitation of the curd is rennet. The rennet is the secretion of the stomach of various animals, that of the calf being most highly priced for cheese making. The fourth stomach of the animal is the one which is used in the manufacture of rennet. The aqueous extract made from these stomachs contains a ferment which has the property of coagulating casein in a very high degree. One part of good rennet preparation from healthy stomachs of calves will coagulate 1000 parts of milk. In former days rennet was freshly made and used at the factories. At the present time it is largely prepared on a commercial scale and sold to the cheese maker. It is highly important that the rennet used in cheese making should be of the best quality, as an inferior grade gives a bad taste and color to the cheese. Just as in the manufacture of fermented beverages and making of bread the character of the yeast is a dominant factor in the nature of the finished product, so it is even to a greater degree in the case of rennet. Those who purchase the rennet already made should therefore be certain it is of a quality to give the desired character to the cheese. The greater the amount of milk fat in milk the larger the proportion of rennet, since the milk fat protects to some extent the casein from the action of the ferment. Experience has shown also that during the summer the rennet acts more readily upon the milk, probably due to the higher temperature. Care should be taken to avoid the use of any excess of rennet, since anything more than the amount necessary to conduct the coagulation is apt to add an unpleasant flavor to the cheese. The curd also in such cases is less cohesive and makes a tougher and drier product which does not lend itself so readily to the ripening process. For this reason the rennet which is to be used should always be tested in small quantities of milk beforehand in order that the proper proportion may be definitely known and the process on a large scale may be conducted with certainty and not by guess. ("British Dairy Farming," by Jas. Long.)

Rennet is sometimes treated with borax to preserve it during transit. In such cases the borax may not all be removed by the whey and is consequently found in ripened cheese. Its introduction in this way should be avoided.

Coagulating the Milk by Rennet Extract.—This process is often termed by the cheese makers "setting the milk with rennet." The milk which is used for the purpose of cheese making should be, in the technical language of the cheese maker, "ripe," that is, containing a sufficient quantity of lactic acid. The principal method of producing the proper amount of lactic acid in milk is by keeping it warm, namely, at a temperature of about 84 degrees. At this temperature the most favorable conditions exist in milk for the rapid growth of the lactic acid ferments. If the natural ferments which produce lactic acid are not in sufficient quantity in the original milk it is better, rather than to wait too long a time, to start the development of the lactic acid by adding an artificial ferment. Lactic ferments are specially prepared for this purpose, or some previously ripened milk may be added to the mass. This is called a "starter." From two to five pounds of "starter" are usually required for each one hundred pounds of milk. The degree of ripening is ascertained by measuring the quantity of lactic acid present. The acid condition of the milk is tested by means of a rennet preparation and if the milk will coagulate, when thus tested, in about one minute or a little more it is an indication that a sufficient amount of acid has been developed to add the rennet for the proper coagulation of the milk. It is important to have the milk in just the right condition in order that the proper operations in cheese making may go on uniformly. Care must be taken, however, not to have too much lactic acid in the milk. For instance, 0.2 of one percent is too great, and such a milk is very liable to give trouble in subsequent operations. In the curding of milk by rennet the temperature should be kept between 82 and 86 degrees. The amount of rennet extract, of course, varies with its character and strength, and this is best determined by the cheese maker's experimenting in order that the proper quantity to be added to the great mass of milk may be known beforehand. A sufficient quantity of rennet extract should be used to curdle the milk in fifteen or twenty minutes for a quick-curing cheese, and in thirty to forty minutes for a slow-curing cheese. The rennet extracts in common use are added at the rate of from one-half to five ounces for 1000 pounds of milk. Before adding, the extract should be diluted with from 20 to 40 times its volume of water at a temperature of from 85 to 90 degrees. The rennet thus diluted acts with uniformity on the milk, preventing the production of curd of a lumpy character. Previous to adding the rennet extract the mass of milk is thoroughly stirred in order to mix the fat therewith and the dilute rennet added evenly and slowly with constant stirring which is continued for several minutes. A gentle stirring of the surface of the milk should be continued until the curd is at least half formed, in order that the fat may not separate. After the stirring is finished, a cloth is placed over the top of the vat to keep the surface of the milk from cooling, and the milk is then left undisturbed until the coagulation is complete. The coagulation goes on gradually until the whole mass of milk is one solid coagulum produced by the changing of casein into paracasein.

Cutting the Curd.—In order that the whey may be separated it is necessary that the curd be cut into pieces. The smaller the pieces of curd, the more rapidly will the whey escape. As soon as the curd is formed it shows a tendency to contract and this tends to force out the whey. By cutting the extent of the surface from which the whey can exude is amplified and the rapidity of the process is enormously increased. The time for cutting the curd is a point of great importance and is determined by the skill and experience of the cheese maker. If the curd is cut when it is too soft there may be a large loss of fat and a decreased yield of cheese. If the curd is too hard the whey is more difficultly removed and the quality of the cheeses is not so fine. The following test is used to determine when the curd is in the right condition to cut. The end of the index finger is inserted obliquely into the curd half an inch or more and then slowly raised toward the surface. If the curd breaks apart with a clean fracture without leaving any particles on the finger and the whey which exudes from the broken surface is clear and not milky it shows the proper time has come for cutting. Specially devised knives are used for cutting the curd, which leave it in small cubes of about one-half inch surface. Skill in the use of the cutting knife is important and can only be acquired by proper experience.

Heating the Curd.—As soon as the curd is cut the whey begins to go out of it and the curd settles to the bottom of the vat, the whey being of a higher specific gravity than the curd. After the pieces of curd sink to the bottom the surface easily reunites and, when broken apart, additional fat is lost. As soon, therefore, as the curd is cut the whole mass is kept in gentle motion by hand stirring or with a wire basket designed for the purpose, care being taken to avoid breaking or comminuting the cubes. When properly stirred the whey appears clear and is free of small particles of curd.

The curd contracts and hardens during this process, and soon reaches a condition when the surface does not adhere so readily. The vat should be kept warm during the process of separation of the whey, the temperature being raised to about 90 degrees and finally, toward the last, to 98 degrees, about blood heat.

Separating the Curd.—The precipitated curd is left in contact with the whey for some time, and during this period some of the lactic acid in the whey unites with the paracasein. The setting of the curd is finished when a small mass which has been squeezed in the hand to remove the whey is pressed against a bar of iron heated to little short of redness, and it is found that there is left, adhering to the iron, fine silky threads. These threads are formed by the compound of lactic acid and paracasein, and the more of this compound there is the longer will the strings be. When the curd shows by the hot iron test strings one-eighth inch long it is an index that the time has arrived for the separation of the curd from the whey.

Gathering the Curd.—After the whey is removed the cubes of curd are left in the bottom of the vat until they mat or pack together, a process which is technically known as cheddaring. The curd is sometimes removed from the vat and placed on a special apparatus for this purpose called a curd-sink. When the curd has matted together, forming a solid mass, it is cut into blocks $8 \times 8 \times 12$ inches. These blocks are turned in the vat in order to facilitate the removal of more whey. The blocks of curd are carefully placed one over the other until they form a large mass.

The process of solidifying or cheddaring accomplishes two purposes:

First, the whey is expelled to a considerable extent and, second, the lactic acid unites with more of the curd, changing not only its chemical composition but also its physical state from a spongy, tough, rubber-like consistence, with a high water content, to a mass having a smooth, velvety appearance and feeling, and a soft, somewhat plastic consistency.

Milling the Curd.—This process consists in cutting the lumps of curd into small pieces in order to introduce the salt and to handle it more readily when it is to be placed in hoops for pressing. This process is conducted in special mills which avoid, in so far as possible, the loss of fat.

Salting and Pressing.—Salt is added for several purposes, chiefly for flavoring, but it also has other uses. It aids in removing the whey,—it hardens the curd and it checks or retards the formation of lactic acid. Excessive salting, however, is injurious. From 2½ to 3 pounds of salt should be added to the curd made from 1000 pounds of milk. Before putting in the press the curd is cooled to a temperature of about 80 degrees, and after putting into the mold it is subjected to pressure to give it a proper form, rather than to remove the whey which is practically all gone by this time. If the whey has not been properly removed before the cheese goes into the press it is almost impossible to get it out then. The pressure should be uniform and continued for at least twenty-four hours. If a screw is used the pressure should be light at first and gradually increased. After the cheese has been in the press about an hour it is removed, turned, a cloth adjusted about it, and the entire surface wiped carefully with a cloth wrung out of hot water.

The sizes in which American cheeses are made depends largely upon the market, the more common size being 15 inches in diameter, and the cheese weighs from 60 to 65 pounds. There is also a very large manufacture of cheeses seven inches in diameter, known as "Young Americas" and weighing only from 8 to 10 pounds.

Curing.—The higher the temperature to which cheese is exposed in curing the more rapidly the curing process takes place, but the poorer the quality of the cheese. Experience has shown that a low temperature, 55 degrees F. or even less, gives much better results, although it requires a greater length of time. If cured at a higher temperature the fat is apt to exude, and will not be evenly distributed in the cheese. It is, therefore, more profitable, as well as better for the consumer, to cure at low temperatures, producing a superior quality with less loss of moisture and a cheese which sells for a better price.

Moisture in the Curing Cellar.—The cellar in which the curing takes place should contain air with a proper degree of moisture. The relative percentage of moisture in the air as compared with the total amount which it can hold should be from 65 to 75. This is determined by placing in the curing room a hygrometer which registers the degree of saturation.

Qualities of American Cheese.—The quality of cheeses is judged by (1) flavor, (2) body, (3) texture, (4) color, and (5) general appearance. In regard to flavor it is impossible to describe what is meant. Only the connoisseur can determine properly whether a cheese has a flavor which is sound, healthy, and indicative of the highest quality. The cheese flavor should be free from any admixture of other flavors. Cheese resembles butter in this respect, that it absorbs and then gives off foreign flavors with great facility. Therefore in the whole process of cheese making care must be exercised to exclude every odor or flavor of an undesirable character from the cheese house.

Flavor.—Under flavor one may also describe taste, which should be of that biting, incisive character due to proper development of ripening and its attendant bacterial and enzymic products. The various foreign flavors in cheese may be due to the odor of cows or the stable or may suggest "rotten eggs," or it may be the flavor of rancid butter due to the decomposition of butter fat in the cheese.

Body.—This is also a term which it is difficult to define. An American cheese is said to have a perfect body when it is solid, firm, and smooth in substance. This quality is ascertained by pressing the cheese between the fingers. When it does not press down evenly between the finger and thumb it is said technically to be "corky." It is smooth when it feels like velvet and is not harsh or gritty.

Texture.—The term texture applied to American cheese refers mainly to its compactness. It is nearly related to body. The texture may be fine and close or porous. The texture is perfect when a cut surface of the inside of the cheese presents to the eye a solid, compact, continuous appearance, free from breaks, holes, or lumps. Cheese should not show any visible or separated moisture or fat. The texture of American cheese should be smooth, free from breaks, and fairly hard. The bandage should be smooth and neat, extending over the edge on each end of the cheese about two inches.

Color.—A true and unadulterated cheese should have only the color of the milk from which it is made, and any other color incident to ripening which is usually green. Unfortunately cheeses of American origin are often artificially colored. An over-deep yellowish or reddish tint, therefore, should be regarded as a mark of inferiority. Artificially colored cheese should not rank as high on the market as that of a natural tint, which is much more pleasing to the eye and much less objectionable to the æsthetic taste. Color is often added to conceal inferiority in the milk used.

The sides of the cheese should be straight and of uniform height all around.

The following scale of points is used in judging cheese, according to the above qualities: Flavor, 45 to 50; texture, 30 to 35; color, 10 to 15; general appearance, 5 to 15.

Cream Cheese.—This is a soft cheese which is rapidly growing in popularity. It is made from rich milk or milk and cream mixed together. It resembles in general Neufchatel, but it is richer in butter fat and is put up in a different form. The temperature of the room in which the cheese is made is quite important. It should be kept as nearly as possible at 75 degrees. The milk is first warmed to 70 degrees and run through a separator by means of which the cream is taken out, together with one-half the volume of milk. This makes either dilute cream or very rich milk, as you may choose to call it. The cream is heated to 84 degrees and about four or five ounces of rennet extract added per thousand pounds. The rennet is carefully and gradually stirred into the mixture, using about fifteen minutes for the addition. The mass is then allowed to remain at rest until whey is seen around the sides. The whey is then removed by draining, the resulting curd pressed and mixed with about 3 percent of salt. The cheese is not subjected to a curing process. It is molded into rolls from 3 to 4 inches in length, wrapped in thin paper and tinfoil, and in this condition packed for shipment.

Manufacture of Foreign Types of Cheese in the United States.—The improvement of cheeses made in the United States by securing different forms of ferments and utilizing the best method of setting, pressing the curd, and ripening used in other countries is worthy of all encouragement. Unfortunately a disposition has arisen in our country of giving the names of foreign varieties to the domestic articles. Many fancy domestic cheeses are sold under strictly foreign names such as Cheddar, Stilton, Cheshire, Schweitzer, Limburger, Camembert, Brie, Roquefort, etc. In fact there seems to be no limitation upon the adoption of a name already identified with a distinct type and locality. Such a tendency is greatly to be regretted and perhaps it is only necessary to point out to our people the ethical offense which they are committing by such practices to secure their discontinuance. It is, however, a perfectly legitimate undertaking to import the ferments which produce the famous cheeses of the world and utilize them to the fullest extent in cheeses of American origin. This, however, should be done in such a way as to carefully avoid applying the name of the original article to the domestic product. Perhaps it would be no ethical offense or not a very great one to place upon the labels of the cheese products a statement that they are of the same type as the foreign product they imitate. This, however, should be an explanatory phrase and not a part of the label which attracts principal attention. It is far better that a manufacturer should adopt some local name which would become identified with his product, and thus become a valuable trade-mark. The attempt to pass domestic cheese under foreign names is an offense against good ethics and also against the law. It is nothing more nor less than misbranding, and cannot be justified even in the absence of a law forbidding it.

Success with Foreign Ferments.—Considerable success has attended the introduction of the foreign processes into the United States, together with the ferments which produce the cheeses abroad. The environment, however, cannot be imported and therefore the ferments may rapidly assimilate different properties under changed conditions, and the continued importation of fresh ferments may be necessary to preserve the type of cheese. Some of the principal types of foreign cheeses made in the United States are those which are mentioned above. A particularly excellent study has been made of the process of making a Camembert type of cheese in this country. (Bureau of Animal Industry, Bulletin 71, 1905.) This particular cheese is a type of Camembert which is made at the Storrs Agricultural Experiment Station of Connecticut. For these experiments a cheese maker familiar with the Camembert manufacture in France was secured. The method of making the cheese and also of separating the curd and ripening was as nearly as possible like that used in France. The style of the packages was the same, so that from external appearances it would be quite difficult to distinguish them from the genuine Camembert cheese of France. The success attending these experiments shows that it is possible to improve domestic cheeses by scientific effort in the direction of using the proper ferments. These soft cheeses made in Connecticut were of good quality and had something of the flavor and type of the Camembert itself, though it was not difficult for even a novice to distinguish the two varieties from one another.

These studies above referred to have resulted in a marked degree of progress in the knowledge of the real changes which take place in the ripening of cheeses. The officials in charge of the work differ somewhat with the author in respect to the character of the product; claiming that the making of Camembert cheese is not dependent upon uniform conditions obtained only in certain localities but rather on securing the proper cultures and conditions which are possible almost anywhere. The fact of the case is that the cheeses made at the Connecticut station are probably made under much more scientific conditions and much more rigid control than the real Camembert cheese made in France. The success which attended these efforts is only a proof of the statement made above that the introduction of these processes for making fancy cheeses in this country will doubtless result in the development of types of American origin of peculiar flavor and quality. Such cheeses when properly named and not confused with those of foreign origin will become quite as familiar and well known, both at home and abroad. (Bureau of Animal Industry, Bulletin 82, 1906.)

Sage Cheese.—The consumption of the variety of cheese known as sage cheese is not very large at the present time in the United States and is restricted to certain localities, yet it is rapidly growing in favor. Consumers who are accustomed to it are willing to pay a larger price for it than for ordinary cheese. Sage cheese is made exactly in the same manner as that described for the manufacture of Cheddar. The flavor of sage is imparted in three different ways, first, by adding the sage extract or tea to the milk; second, by adding the extract to the curd before salting; third, by adding the sage leaves to the curd before salting. The latter method is found to be the most satisfactory requiring the least amount of sage to give any definite flavor. Three ounces of sage leaves are found to be sufficient to flavor the curd from 1000 pounds of milk. The stems and impurities of the sage leaves are carefully removed and the leaves ground to a fine powder before mixing with the curd (Michigan Board of Agriculture, 1904).

Principal Cheeses of England.—The principal English cheeses are Stilton, Cheshire, Cheddar, double and single, Gloucester, Derby, and Leicester. According to Dr. Voelcker, the finest flavored cheese is Cheshire, which differs from any other in being made from milk which is perfectly sweet, and some authors think its peculiar aroma is due to this fact. On the contrary, the more general opinion is that the best cheeses are made from milk slightly sour rather than that which is perfectly sweet.

Cheshire cheese is manufactured by mixing the evening milk, which is kept cool over night, with the morning milk, and then warming the mixture until the temperature is about 90 degrees. The proper quantity of rennet is added and when the cheese is to be extremely yellow also some annotto. After thoroughly mixing, the mass is left for nearly an hour, by which time the coagulation is completed. The next operation is the breaking down or cutting up of the fresh curd, and this is an important process. Upon the care which is exercised in doing this depends in a large measure the richness and quality of the finished product. When properly manipulated the whey which is separated will be of a greenish color and clear, while the proper combination of milk fat and casein which is secured in separating the whey will make a cheese of first class quality. The curd is so dense as to naturally separate from the whey by deposition, and the latter is thus drawn off by a stopcock properly placed in the vat. The curd is then placed upon a cloth stretched over lattice work in order that the separation of the whey may be complete. Finally before passing to the cheese house the curd is treated with eight ounces of salt to twenty pounds of curd. After the cheese is molded it is placed in a warm room for one or two days, and then taken to the press house where it is subjected to the usual pressure. The pressing process is continued by wrapping the cheese in dry cloths and subjecting to new pressure every day for five or six days. The cheese is then removed to the ripening cellar where it is turned two or three times a week. It is ripe and ready for consumption in less than one year. There are a great many variations from this method of making Cheshire cheese, but they all follow the same general plan.

Manufacture of Cheddar Cheese.—The Cheddar cheese is made in various parts of England though chiefly in Somerset, the period of manufacture extending from April to November. Cheddar cheeses are made in large sizes varying from 60 to 100 pounds each. The temperature of precipitation for Cheddar cheese is somewhat less than for the Cheshire cheese, being about 80 degrees. Rennet is used solely in the coagulation, lactic acid not being liked for that purpose. In the making of Cheddar often some of the fat escapes in the whey and this is afterwards collected and made into butter. Two pounds of salt to 100 pounds of curd are used.

Derby cheese is a name applied to cheese made in Derby. The Cheddar system of making it is usually employed.

Gloster cheeses are made on the same plan as that of the Derby and do not need any further description.

Leicester cheese is a variety of cheese which is very popular and made chiefly in the county of Leicester. The coagulation of Leicester cheese is made at a little lower temperature than that previously described, varying from 76 to 84 degrees. The curd is allowed to stand for about one-half hour before it is broken up and the whey separated. The best manufacturers of cheese disapprove of the use of artificial coloring and it may be said that eventually it is pretty certain that all cheese makers will come to the same conclusion. The use of coloring matter in cheese, even of annotto, adds nothing to its richness, and tends to deceive the customer into thinking that the milk employed was richer in cream than it really was. The Leicester cheeses are small in size compared with Cheddar. About eleven pounds of milk are used to make an ordinary cheese.

Stilton cheese is probably the most familiar and highly prized of all English varieties. It is not always to be obtained, and many imitations of Stilton are made and bear its name. The name it bears is from the name of the town where it was first, and is now, made. It is a cheese which has been known for about a century and a quarter. It is principally made between March and September and solely from the milk of cows fed on natural pasture, that is, for the finest variety. The use of artificial food for the cows is at once detected in a change for the worse in the character of the cheese. At first the rennet employed was made from the stomachs of lambs instead of cows and in the olden times the cheeses were not considered to be sufficiently mellow and ripe until they were two years old and exhibited spots of green in the interior.

The most approved modern process of manufacture is mixing the morning and evening milk and bringing it to a temperature of 79 degrees. Rennet is then added and the mass allowed to stand for about an hour and a half. The curd is removed into cloths set in frames for the purpose of allowing the whey to separate. Usually about an hour is allowed for the natural separation. The cloths are then tightened and drawn closer in order to produce a slight pressure and placed in a cheese tub, several of them together, where they are allowed to remain for twelve hours. Usually a longer time is allowed before the curd is cut up. The salt is added in proportion of one pound to 60 pounds of fresh curd. The curd is then placed in tin cylinders with perforated sides, the cylinder being 12 inches deep and 12 inches in diameter, and put in a room at about 65 degrees to favor the separation of the whey which requires from six to seven days. The cheeses are then removed from the cylinders, brought into proper shape by a knife and wrapped with strong cotton cloth and allowed to remain for twelve days longer when they are removed to the drying room and kept at 65 degrees. During this process the original curd placed in the cell loses about one-half its weight so that ten pounds of curd in the end make five pounds of cheese. A very common method also is to make cheese twice a day from morning milk and evening milk separately. Extra cream is often added in making Stilton cheese, only whole milk or milk and added cream being used. The principal point to be considered with curing is the regulation of the temperature.

Other varieties of cheese which are known in England are mostly named from the localities where they are produced and partake in general of the character of cheeses already described. These are Lancastershire, Wensleydale, skimmed milk cheese, butter milk cheese, potato cheese, and various forms of soft cheese or those used without being allowed to ripen for any length of time.

Varieties of Cheese Made in France.—There is a general idea that France is pre-eminently a cheese making country and this is true in so far as the making of certain brands of cheese which have international reputations is concerned. France, however, according to statistics, imports a larger quantity of cheese than she exports though probably the value of her exports is greater than the imports because of the high character and price of the exported articles.

Manufacture of Camembert.—The first cheese of this variety was made in 1791 by Marie Fontaine on a farm in the community of Camembert, near Vimontiers. The period of manufacture of Camembert cheese extends from March to September. It is made from whole cow's milk from which none of the cream has been extracted. The rennet is added at the temperature at which the milk comes from the cow as nearly as possible and the milk is artificially heated, the morning and evening milk being mixed, to this temperature. After the addition of rennet the milk is gently stirred for two or three minutes, a wooden cover placed over the pan, and left for five or six hours. The curd is sufficiently set when touched with the finger it does not adhere thereto. The curd is removed from the pan by a spoon and put into cylindrical metal molds open at the end and from these molds the whey is allowed to escape. It requires about two liters of milk to make one cheese. The whey is allowed to drain for about two days. After that time the mold is turned, a little fine white salt placed upon the top and allowed to drain for another day. After about 48 hours the cheeses are taken from the molds and salted. They are then placed in the drying room upon racks covered with straw. The drying room must be well ventilated and the air which is blown in for ventilation must be strained to be free of dust and insects. Care is taken also to exclude the sunlight, as this is very injurious to the proper development and ripening of cheese. The cheese remains in the dryer from 20 to 25 days. The ripening cellar is the next point to which the cheese is removed, and this cellar is kept as nearly as possible at 50 degrees F. The cheeses remain in the ripening cellar about 30 days, during which time they are frequently turned and carefully watched. The progress of the fermentation which takes place in the cheese is indicated by its appearance. In modern times the manufacture of Camembert cheese is continued practically throughout the whole year, but the artificially ripened cheese, that is, made during the winter by the aid of artificial heat, does not compare in quality with the product which is naturally ripened during the summer months. The manufacture of Camembert cheese has extended to a considerable distance from the original village, but it is all made in that part of France.

Emmenthaler Cheese.—Emmenthaler cheese is a variety of Swiss cheese of the same type as Gruyère. It is sometimes called the "cart-wheel" cheese on account of its immense size. These cheeses are sometimes three or four feet in diameter and of a disk-like shape, something like a wooden wheel sawed out of a round tree. It is a cheese which was originally made in Switzerland, although the manufacture of it has spread over into that part of France bordering Switzerland. It has the general character of Swiss cheese in texture, also in composition and nutritive value.

Brie Cheese.—This is one of the most famous of French cheeses. It is made in the form of a round flat mass about 16 inches in diameter for the grande Brie and 12 inches in diameter for the petite Brie. The thickness of the cheese is about one inch. The method of preparation is not very greatly different from that of cheeses in general. During the curing process, as in the case of Camembert, mould develops, especially on the outside of the cheese, and the change which goes on in the interior breaks down the casein, forming a creamy mass of a strong, piquant flavor. The mould which grows upon the outside of Brie cheese gives it a strong odor which reminds one of decomposition. Brie cheese might be said to resemble in general properties the Camembert variety of cheese.

Roquefort cheese is a very popular cheese made in France from sheep's milk. When properly ripened it shows a green mould. It is made in a particular way at Roquefort, and according to König has the following composition:

Water,	36.85	percent
Fat,	30.61	"
Proteids,	25.25	"
Lactic acid,	1.90	"
Ash,	5.39	"

Port Du Salut.—This variety of cheese has a most deserving popularity, not only upon the Continent but in the United States. It is, however, not so generally known in this country as the Roquefort and Camembert varieties. It was long manufactured by a secret process by the Trappist monks of Bricquebec in the Department of Manche.

The secret of the manufacture of this variety of cheese is guarded with the same jealousy by the monks as is the secret of making the chartreuse liqueur. Port Du Salut is always put up in very small packages of cylindrical form, flat, and about one inch in thickness. The cheese has a number of holes, in which it resembles the Swiss cheese. Its flesh, however, is mellow, and does not have the toughness nor solidity which characterizes the flesh of Swiss cheese. Although the monks' secret has been well guarded the general method of its manufacture has been described ("Cheese and Cheese Making," by Jas.

Long and John Benson). The milk is brought to a temperature of 86 degrees F., and is treated with rennet in such a way as to separate the curd in about one-half hour. The separation of whey is secured in the usual manner, first, by allowing broken curd to stand, and afterwards by pressure. A peculiar form of pressure is said to be used by the monks,—a number of screws are placed side by side on a beam and a number of cheeses may be pressed at the same time. The pressure is applied solely by the hands and so is not very severe. After pressure the cheeses are placed in a ripening cellar, which is kept at about 54 degrees F. Care is taken in the ripening that the cheese does not become too dry.

Pont L'Evêque cheese is well known upon the Continent, especially in France where it is made. It takes its name from the village where the manufacture is carried on, which is not very far from Havre. The cheese is usually put up in a square or oblong package about one inch in thickness and of a size weighing about one pound. It has a tough crust and may be kept for some time after it is ripe with safety. The milk is set at a temperature of 88 degrees and a sufficient amount of rennet added to produce precipitation of the curd in about fifteen minutes.

When the curd is stiff enough to be cut and removed it is placed upon a mat made of rye straw through which the whey is allowed to filter. As the whey runs off the curd becomes tougher and the mat is brought together in such a way as to exert gentle pressure. This separation of the whey is continued until the curd can be placed in metal molds which vary in size according to the size of the intended cheeses. The cheese is ripened at a temperature of about 58 degrees in a humid cellar so as not to lose too much water.

Gervais cheese belongs strictly to the family of fancy cheese, being made of a mixture of milk and cream. It is produced in large quantities in France and finds almost an exclusive domestic market. It is named for its manufacturer, M. Gervais. The mixture is set at a very low temperature, about 65 degrees. The rennet which is used is diluted with water and added in small quantities so that the curd does not separate for eight or ten hours. The whey is separated in a cloth bag and under very gentle pressure. The cheeses are usually sold in only a partially ripe state and the cheese combines the flavor of both cheese and cream.

Bondon cheese is another cheese which is made largely in the region of Rouen. The size of the cheese is usually very small, from seven to nine being made from a gallon of milk. The method of manufacture is more like that of Gervais and differs from it chiefly in being made solely from milk instead of a mixture of milk and cream.

Limburger Cheese.—Limburger cheese is one of the most famous of the different varieties of foreign cheese, chiefly because of its bad odor. This odor is due to specific forms of ferments introduced during the ripening process. Generally Limburger cheese is made from pure milk, but occasionally skimmed or partially skimmed milk is used. The milk is set at rather a high temperature, from 92 to 100 degrees. After the coagulation has taken place the curd is broken into pieces the size of a hen's egg and allowed to settle to the bottom of the kettle as the whey separates. In England a copper kettle is usually employed for the testing vessel. After the whey has separated the curd is taken out and placed in rectangular molds with perforated bottoms, then laid on tables so that the remaining portion of the whey may drain off. The molds are turned from time to time to promote the separation of the whey and to make the cheeses keep their form. The cheeses are next placed in rows on a flat table with thin pieces of boards between them and subjected to light pressure. During this time they are salted by applying salt externally and rubbing the surface at frequent intervals for three or four days. The salt dissolves and permeates the mass. During the salting and pressing the cheeses are kept at a uniform temperature of about 60 degrees. The curing takes place in cellars, well ventilated but very moist, at a temperature of about 60 degrees. As the cheeses ripen they grow soft. The curd takes on its characteristic greasy appearance at the time of the ripening, becoming, at first, a yellow and then a reddish yellow. The softening begins on the outside and proceeds toward the center and the cheese is considered to be marketable when one-fourth of it has taken on its characteristic texture. The softening of Limburger cheese is due to a ferment which breaks down into a soft mass the casein or paracasein of which the cheese is largely composed. By using the same kind of ferments and by following the same process, imitations of Limburger cheese are made in the United States and other countries. These imitations, however, never equal the original in the character of the product nor in flavor or taste, and should not bear the name of the real article.

COMPOSITION OF LIMBURGER CHEESE.

Water,	35.7	percent
Fat,	34.2	"
Casein products,	24.2	"
Milk sugar and undetermined,	3.0	"
Ash,	2.9	"

Limburger cheese was first made in the Province of Lüttick in Belgium. It has, however, come to be considered chiefly as of German production. The chief cause of the putrefactive fermentation which takes place in Limburger cheese is the extremely moist condition in which it is kept. For this purpose the atmosphere of the ripening cellar should be almost saturated with aqueous vapor, containing at least 95 percent of its maximum degree of saturation. This moist atmosphere, together with the low temperature at which the curing takes place, keeps the cheese soft and promotes the putrifactive ferments. Under these conditions the surface soon begins to get shiny and soft and changes from white to a reddish yellow. This change makes its way to the center, converting the harsh curd to a soft condition. The time required for this softening of the cheese is from four to six weeks. ("Cheese Making," by John W. Decker.)

Edam Cheese.—Edam cheese is one of the most famous of the cheeses of Holland. It is made at the town of Edam, situated on the Zuyder Zee, about twelve miles northeast of Amsterdam. The milk from which Edam cheese is made should be properly acidified as has already been described. The coagulation takes place and the curd is separated by much the same method as is used in the manufacture of Cheddar cheese. The curd is held for a time in the vat in a granular condition in order to develop greater acidity and until it will string one-half inch or one inch on the hot iron already described. It is then ready for the mold. The molds are of such a character as to give the cheese a spherical shape about six inches in diameter. Each cheese weighs about four pounds. It has a perfectly solid texture and its flavor is something like that of old Cheddar, except that it is a little more salty and somewhat harder. It is cured at a temperature of about 60 degrees and at a humidity of about 80 degrees. The curing period is somewhat longer than for most cheeses, lasting about eight or ten months and even a year. A slow curing is particularly necessary in the production of Edam cheese.

Coating with Paraffine.—In the curing of cheese sometimes it is coated with paraffine to avoid loss of weight. Coating with paraffine does not necessarily interfere with the character of the cheese, though it is probable that it must interfere in some way with the normal ferments. Paraffine is wholly indigestible and may produce injurious effects if swallowed with the cheese. ("Farmers' Bulletins," Nos. 186–190.)

Fancy Cheeses.—There is a large number of cheeses made in which cream enters as a prominent part. It is difficult to give these any particular name and the term "fancy cheese" has been applied to this form of cheese as a whole. They are usually put up in small packages or little pots and thus form an article of diet quite distinct from the large press cheese of commerce. In fact they are intended more for condimental purposes and to be eaten in something of the same manner as butter rather than cheese. These cheeses usually are sold for a much higher price and, therefore, can be regarded more as a luxury than as a regular article of diet.

It might be well to mention some of the more particular varieties of these fancy cheeses.

Gruyère.—Gruyère is a cheese made in Switzerland, where it is much prized and from where it is sent to the various parts of the world. It is a pressed cheese of a somewhat larger size than the fancy cheeses already described, and it is difficult to say whether or not it should find a place among them.

Parmesan.—Parmesan is a variety of cheese made in Italy. It is about the same size as Gruyère and thus has an intermediate place between the large pressed cheeses of commerce and the fancy cheeses above mentioned.

Gorgonzola is an Italian cheese mottled by a chromogenic penicillium much like Roquefort. It is in one sense a fancy cheese and yet is made in such quantities as to belong rather to the commercial varieties. It is manufactured chiefly in Lombardy.

Bacterial Activity in Cheese.—Modern science has led to the conclusion that the ripening of cheese is due principally to bacterial activity. The changes which take place in the chemical and physical properties of cheese materials, the flavor and aroma which are developed, the production of mould and other growths are marks of the activity of organisms of different character, living and unorganized. Due credit must be given to the enzymic (unorganized) action in these processes and the enzymes are not regarded as living organisms but, on the other hand, as catalytic agents inducing chemical changes similar to those produced in starch by the action of diastase. The peculiar flavors of cheeses which are found in different kinds have been ascribed in late years almost exclusively to the character of bacterial activity. This assumption is perhaps correct, but it must not be forgotten in this connection that the same species of bacteria, in changed environments, does not always produce the same results. The activities of bacteria are peculiarly sensitive to the environment, such as change of temperature, physical conditions of different kinds, locality, and other factors of a complex nature, making up the total conditions in which the organisms live. For this reason the attempts to produce peculiar cheeses which belong in particular localities in other localities have not been gustatorily even if technically successful. It is true that cheeses may be made of the types mentioned, having some of the general characteristics but lacking that indescribable something which after all gives true character. Just as it is impossible to make a Rhine wine in California or a Bordeaux wine in New York so is it impossible to make a Cheddar cheese in Ohio or a Camembert cheese in Connecticut.

Number of Bacteria.—The number of bacteria, per gram, which appear in cheese varies according to the age of the cheese, conditions under which it is made, temperature, etc. The usual number of bacteria in one gram of cheese varies from five hundred thousand to nearly one hundred million (21st Annual Report of the Wisconsin Agricultural Experiment Station).

Aging does not seem to increase the number of organisms, since it has been found by some observers that the maximum number present in cheese is found at the time it is taken from the press. It is difficult also to properly sample a cheese for the number of bacteria, since they are unequally distributed in different parts thereof, and the trier, by means of which the sample is secured, may show largely differing numbers in different parts of the same cheese. During the process of curing, especially if the curing be at a high temperature, the number of organisms decreases. At first the decrease is very rapid and then becomes slower as the cheese becomes riper. The decrease in the number of bacteria when the temperature of curing is raised is somewhat contrary to expectations. It has been found that when a cheese is taken from cold storage, say at 24 degrees F., and placed in a temperature of 60 degrees F., the decline in the number of bacteria is always greater than when the cheese is retained at the lower temperature. This may be due to the fact that bacteria which have been developed at a low temperature may lose their vitality at a higher one. Furthermore, the development of flavor does not seem to depend upon the number of organisms since the peculiar flavor of cheese is more rapidly developed at the higher temperature, provided it be not too high, although this be attended with a diminution in the number of organisms. Evidently the conditions which favor the metabolic activities of organisms also favor their destruction, since when they have performed their functions they undergo natural disintegration. The character of cheese is such that when it is once formed there is no more opportunity given for a rapid proliferation of the organisms.

It may be found, however, that the development of bacterial life is not the sole or perhaps not the dominant factor in the development of flavors and aromas in cheeses but that this process is due very largely to the enzymic activities obtained from the rennet and which pre-exist in the milk.

Chemical Changes Which Take Place During the Ripening of the Cheese.—*Loss of Weight.*—During the process of ripening of cheese there is considerable loss of weight, amounting to from 15 to 20 percent of the total weight of the fresh product. This loss is due chiefly to the evaporation of water, while in the fermentation which takes place volatile bodies are formed which also escape with the water. For instance, any free gas, either carbon dioxid, hydrogen, or nitrogen, which is produced will escape, likewise any alcohol which is formed will at least partially volatilize. There may be also a slight loss due to mechanical attrition, but that is not of any consequence. Owing to the loss of water some of the constituents which may diminish in actual quantity have their percentages proportionately increased. These changes are illustrated by the following analytical data:

	Water.	Protein.	Fat.	Milk Sugar.	Ash.
Fresh cheese,	40.42	24.80	28	1.65	5.43
In the dry substance,	....	41.62	46.99	....	....
Same cheese one year old,	33.12	27.35	31.70	2.96	4.87
In the dry substance,	....	40.89	47.40	....	....

The quantity of water which is lost in part depends upon the temperature of the store house and the dryness of the air. The loss of water should not be too great, otherwise the cheese would be dry and the ripening process would not go on in a proper manner. In some of the processes which take place during the ripening of cheese water is formed. If, therefore, there is no loss of weight during the process of ripening, the ripened cheese would have more water than the fresh cheese and this would impair the quality of the product. The loss of a certain part of water, namely, from 15 to 20 percent must be regarded as an advantage in the production of cheese.

Changes in the Protein.—The most important chemical changes, from a digestive point of view, which take place in the cheese are those which the protein undergoes. This protein substance consists chiefly of casein and undergoes profound alteration due to enzymic action during the process of ripening. The casein which when dry naturally forms a leathery, tough material changes into a more soluble and softer product, and during this change there are produced aromas and flavors which add much to the value of the cheese for edible purposes.

The character of the coagulation of the cheese originally has much to do with the general changes which the product undergoes during fermentation. The cheese makers for this reason must pay special attention to the rennet which they employ in the production of the precipitate. One of the most important of the changes which the casein undergoes is that which results in the production of ammonia. This indicates a complete decomposition of the protein substance, at least in part, so that the total amount of protein which is lost as such may reach as high as 25 or 30 percent of that present in the original cheese. There are also produced notable quantities of lucin and other nitrogenous compounds soluble in alcohol. In general it may be said that the changes in the nitrogen constituents of cheese are extremely helpful to digestion. Not only is the protein of ripened cheese more soluble but even the parts which remain unchanged as far as the protein constituent is concerned are so affected by the action of fermentation as to render them more readily subject to the action of the digestive ferments in the alimentary canal. There is a popular superstition that the use of cheese at the end of a meal helps to digest the other food which has given rise to the adage "Cheese, thou mighty elf, digesting all things but thyself." There is a base of scientific truth in this expression since in ripe cheese the enzymes remain still in an active form and when taken into the stomach must necessarily exercise an influence of considerable magnitude upon the process of digestion. The custom, therefore, which is so universal, of finishing a dinner with a bit of cheese is evidently based upon sound physiological as well as gastronomical principles.

Changes in the Fat.—The chemical changes which the fat undergoes in the process of ripening the cheese are also of considerable importance. It is claimed by some authors that additional fat is produced from the casein during the process of ripening, which is the cause of the lardy appearance of some cheeses. Many observers have found in ripened cheese a larger percentage of fat than that which was noticed in the fresh cheese. This apparent increase, however, may be due to analytical error, since in the fresh cheese the fat becomes entangled with highly insoluble caseous matter and is difficult of extraction, whereas after the ripening of the cheese and degradation and breaking up of the caseous tissues the fat is much more readily extracted. While it is not impossible that fat should be formed by the fermentation of the casein it does not seem that it is probable.

In examinations which were made of fresh and ripened cheese of the variety known as Roquefort there was found in the dry substance of the fresh cheese 40.80 percent of protein and 53.91 percent of fat. In the same cheese after it was quite old there was found in the dry substance 37.78 percent of protein and 56.14 percent of fat. These data serve to bear out the theory that fat is formed from the protein. On the contrary, it must be remembered that in the fermentation of the protein a number of volatile bodies are formed, especially ammonia, and thus the diminution in the percentage of protein is probably due to the loss of volatile bodies, and the increase in the quantity of fat is therefore a relative one, probably, and not absolute. There is no doubt, however, of the fact that the quantity or character of the fat does change considerably during the process of ripening. There is no reason for supposing that the fat alone of all the contents of cheese escapes enzymic action. It is profoundly changed in its character by the fermentations to which it is subjected, and this change, while it unsuits the fat for butter, may probably make it more palatable and desirable in cheese.

Digestibility of Cheese.—Reference has already been made to the fact that in the ripening of cheese the protein of the milk, consisting principally of casein, undergoes certain changes which apparently, at least, increase its digestibility. I use the word "apparent" because the flavor and aromas which are produced in the ripening of a cheese act as condimental substances and thus naturally excite the glands which secrete the digestive enzymes to greater activity. Therefore the increased digestibility may be due in part to the increased activity of the digestive ferments as above described rather than to the changes in the casein itself. It must be admitted, however, that these changes during ripening tend to make the casein more granular, softer, and to convert it into compounds more easily acted upon, and are thus favorable to increased digestibility. Experimental studies have shown that in a well ripened American cheese of the Cheddar type 93 percent of the protein present in the cheese and 95 percent of the fat are digested. Artificial digestion experiments have also shown that the pancreas ferments have much more effect upon cheese digestion than the peptic, showing that the cheese is acted upon more in the small intestines, perhaps, than in the stomach. Attention must also be paid to idiosyncrasies in these cases, as there are many people who find it impossible to digest cheese in any form. The eating of larger quantities than are necessary also tends to derange the digestive organs. A well ripened cheese, therefore, should be eaten rather as a condimental substance than as an actual food product, though its value as a food is fully attested. ("Farmers' Bulletin," No. 162.)

Effect of Cold Storage on the Curing of Cheese.—Attention has been called, in the description of different methods of making varieties of cheeses, to the ordinary temperature at which cheeses are cured. In European countries these temperatures are maintained without the use of artificial means. In the United States it is difficult to maintain a very low temperature in summer time without the use of artificial refrigerators. Experimental studies have determined that when the temperature of ripening or storage is reduced to a considerable extent below that usually specified for the standard varieties of cheese the quality of the cheese is preserved although the time of ripening is very much prolonged. The artificial curing of cheese has been secured at as low a temperature as 40 degrees. There is also less loss of weight in cheese cured at this low temperature. It is evident that in the curing of cheese the temperature should not be reduced below a point which prevents proper enzymic activity. After the cheese is ripened the temperature of storage may be reduced to the freezing point or even lower.

Preparations of Casein.—Properly in connection with cheese preparations may be mentioned those products which are of a food value, procured from casein itself. The precipitated casein is prepared for the market by washing, drying, and grinding to a fine powder, and is then sometimes called protein flour. Sanose is a mixture consisting of about 80 percent of casein and 20 percent of the protein derived from the white of egg. The addition of the white of egg enables the casein to remain in suspension when mixed with water and thus causes the preparation to resemble milk. Casein preparations of this form are practically insoluble in water and, therefore, perhaps are not the best forms of nitrogenous food for invalids. To avoid this insolubility the casein has been combined with alkalies and the preparations are known as *nutrose* and *eucasein.* Plasma is also a preparation of casein with alkalies which are added in sufficient quantities to give 7 percent of ash. These caseinates, as they are sometimes called, that is, combinations of casein with alkalies, are soluble in water and are found to be to a certain extent digestible and nutritive preparations. Casumen and sanatogen are other preparations of casein with alkalies or glycero-phosphate. Wonderful claims are made by manufacturers concerning the digestibility and nutritive properties of these preparations. It is doubtful, however, if they have much greater value, if any, than natural casein in the form of milk or as ripened in cheese. Preparations of this kind usually appeal strongly to those who suffer from digestive disorders and therefore high-sounding names, which are given to practically the same preparations, lead the seeker after health often to try the same substance under a dozen different appellations. These remarks are not made for the purpose of decrying in any way the merits which these preparations may have but only to illustrate a very marked tendency on the part of many people to attribute extreme virtues to ordinary food substances which are sold under attractive and sometimes deceptive names and whose properties and virtues are advertised in an expert manner. Because a food substance consists almost wholly of pure protein is no indication whatever of its exceptionally high food value. Protein is only one form of food and a concentrated ration of protein in any of these forms is just as likely to do harm as good. For emergency rations, for economy in transportation, and for certain diseased conditions of the digestive organs these preparations are undoubtedly valuable, but they have little claim upon the general public in a state of health as staple articles of diet. They are much more nutritive than the extracts of beef and other meats which have obtained a vogue wholly out of proportion to their dietetic or medicinal value. ("Foods and Principles of Dietetics," by Robert Hutchinson.)

Cheese Compounds.—The trade in manipulated cheese is one of some magnitude. The cured cheese of commerce is reduced to the state of a paste, mixed with butter sometimes and also regrettably with a preservative, usually borax, packed in small vessels, and sold under some distinctive or proprietary name. When not chemically preserved there is no objection from a sanitary point of view to such a product. It is in a form convenient for use, easily transportable, and well suited to use at a picnic or during travel. Many people are fond of these preparations, preferring them even to the natural cheese. The price of such products, however, is usually much greater than that of the natural cheese, and for this reason they are not likely to come into general use.

Consumption of Cheese.—Cheese is by no means as generally consumed in the United States as it is in many European countries. No matter how poor the peasant may be in Europe cheese is not unknown to his diet. When not used directly as a food its condimental properties are utilized. It is grated into the soup or used to season the macaroni or to add zest to the simple dessert. Its condimental value should be better understood among our people and it may be used with great economy in the replacement of meat in many cases. The more general teaching of scientific dairying in the agricultural schools of our country ought to improve the character of our product and increase its consumption. One of the obstacles which has impeded the growth of cheese-eating in the United States is the lack of knowledge among our farmers of the proper methods of cheesemaking in a small way. The establishment of the neighborhood cheese factory has already led to a marked increase of the area in which cheese is made.

PART V.

CEREAL FOODS.

BARLEY (Genus *Hordeum*).

In the United States barley is not used to any extent as human food. It has all the nutritive properties of the common cereals and may be considered as a food product, although its chief use is in the making of fermented beverages which will be described in full in the second volume.

Barley is cultivated chiefly in the northern and western portions of the United States and is similar to the oat in this respect, that when the grain is threshed by the ordinary process the first layer of chaff is not separated, and, therefore, it goes into the market unhulled. There are varieties of naked barley which are not much cultivated. The cultivated varieties (*Hordeum sativum* Pers.) belong practically to one species, although there are very many different varieties grown.

The character of barley best suited to malting will be discussed in the second volume.

Acreage and Yield of Barley.—The area planted to barley in the United States and other statistical data relating thereto for the year 1909 are as follows:

Acreage,	7,011,000	
Yield per acre,	24.3	bushels
Total production,	170,284,000	"
Price per bushel,	55.2	cents
Value of crop,	93,971,000	dollars

Composition of a Typical Unhulled Barley.—From a comparative study of a number of samples of American barley the following numbers are regarded as typical of the composition of the unhulled barley grown in the United States:

Weight of 100 kernels,	4.53	grams
Moisture,	10.85	percent
Protein,	11.00	"
Ether extract,	2.25	"
Crude fiber,	3.85	"
Ash,	2.50	"
Starch and sugar, etc.,	69.55	"

The important points brought out in the above data are that the percentage of fiber in the unhulled barley is less than one-half that of the unhulled oat, as stated further on, while the percentage of ether extract is only about one-half that of the unhulled oat, and the protein is also decidedly less than in the whole oat.

As has been stated, barley is not very generally used in this country for human food, but is used in this and other countries as an ingredient of soup.

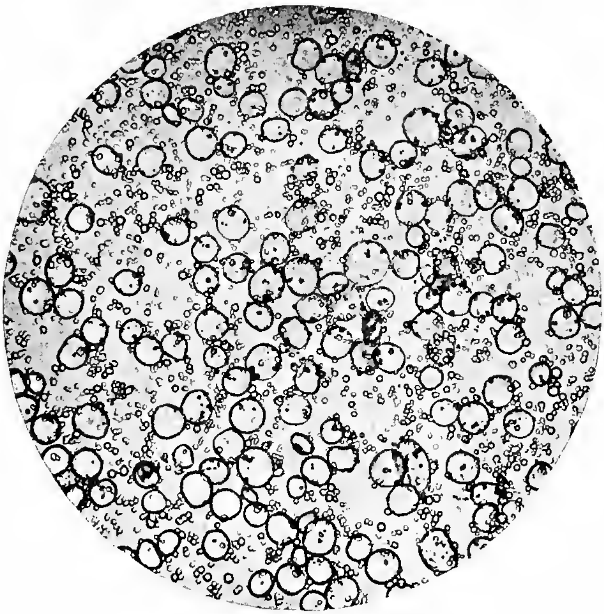


FIG. 22.—BARLEY STARCH. × 200.—(*Bureau of Chemistry.*)

Protein of Barley.—The following protein compounds are found in barley in proportionate weight to the total weight of the seed:

Leucosin,	0.30	percent
Hordein,	4.00	"
Edestin,	1.95	"
Proteose,	1.95	"
Insoluble protein,	4.50	"

As seen from the above table the most important of the soluble proteins is hordein, which in quantity is almost equal to the insoluble protein of the barley grain. The starch granules of barley are recognized by their distinctive shape and size, as revealed by the microscope. A typical microphotographic view of barley starch is shown in Fig. 22.

BUCKWHEAT (*Polygonum fagopyrum* L.).

Buckwheat is usually classed with the cereals, but botanically it does not belong to the order of true grasses to which the cereals belong.

Buckwheat is commonly grown in many parts of the United States, and its seed is highly prized for bread and cake making purposes. The buckwheat is ground and the outer black tough hull separated, and the flour is used chiefly for making hot breakfast cakes which are much prized throughout the country. Properly ground buckwheat flour has a more or less dark tint, due to fine particles of the outer envelope which escape the bolting process.

Acreage and Yield of Buckwheat.—This crop is not grown in many states. New York, Pennsylvania, and Michigan produce the largest quantities. The statistical data for buckwheat grown in the United States in 1909 are as follows:

Acreage,	834,000
Yield per acre,	20.9 bushels
Production,	17,438,000 "
Price per bushel,	69.9 cents
Total value,	12,189,000 dollars

Composition of Buckwheat Flour.—The composition of finely bolted buckwheat flour is as follows:

Moisture,	11.89	percent
Protein,	8.75	"
Ether extract,	1.58	"
Ash,	1.85	"
Fiber,	.52	"
Starch and sugar,	75.41	"
Calories per gram,	3,854	

The above is the composition of a white flour more finely ground and bolted than is advisable for palatable purposes. In the grinding of the above flour the germ, which contains a large part of the ether extract, is eliminated and also a large quantity of the bodies rich in protein. The composition of a less highly refined flour and one which is more palatable and more nutritious is given in the following data:

Moisture,	11.19	percent
Protein,	9.81	"
Ether extract,	2.33	"
Ash,	1.53	"
Fiber,	.73	"
Starch and sugar,	74.41	"
Calories per gram,	3,954	

Milling Process.—In the preparation of the so-called highest grade of buckwheat flour, that is, that which is most carefully ground and thoroughly bolted, the process employed is as follows: During the process of milling the buckwheat grains pass to a receiving separator which removes all the coarse particles, stones, straws, etc., by means of a series of sieves. At the same time any dust which they contain is blown out by a current of air. The sifted grains pass next to the scouring machines, in which they are thoroughly scoured, cleaned, and polished. From these machines the grains pass to a separator containing magnets, by means of which any pieces of metal, in the form of nails, screws, pieces of wire, etc., are removed.

The grains next pass through a steam dryer for removing the greater portion of the water employed for the scouring. As soon as they are dry they are again treated to a blast of air, which removes any dirt, dust, or light particles which may have been detached during the process of drying. The grains next pass to the shelling rolls, where the greater part of the outer hulls is removed. This process is accomplished by means of an apparatus which is called a sieve scalper. After the separation of the outer hulls the residue of the material passes to a drying chamber, where the moisture is reduced to about 10 percent, thus insuring the keeping qualities of the flour. After drying the grains are ready for the rolls. After entering the rolls the process is practically the same as that which is employed in milling wheat, consisting of a series of breaks and reductions, with the attendant bolting and grading and this process is prolonged until the flour is practically removed from the feed or middlings. The sifting cloths used in the bolting of buckwheat flour are somewhat coarser than those for wheat, and this allows some of the dark particles of the inner hulls to pass into the flour, which gives it a dark color on baking. It is quite possible to make a buckwheat flour as white as that from wheat, but in this country the public taste requires a darker product, so that the white flour does not readily sell. The requisite degree of darkness is secured by using bolting cloths which will allow a part of the inner hulls (middlings) to pass into the flour. Two grades of flour are generally produced —a whiter one in which finer cloths are used, and a darker flour made by using coarser bolting cloths, allowing larger quantities of middlings to pass through. The outer hulls which are first removed are used for fuel, although from their composition it is seen that they contain a large quantity of carbohydrates and might be very profitably used in connection with some highly nitrogenous food, such as cottonseed meal or flaxseed meal for feeding cattle. The middlings are used principally as cattle food, and especially by dairymen.

The above process, while it makes a white and fine-looking flour, is not to be compared with the meal made in the old-fashioned way of grinding between stones and separating the principal part of the outer hull by bolting. This old-fashioned flour is more nutritious, that is, it contains more fat and protein, has a greater fuel value, or in other words has a greater number of calories and makes a much more palatable cake than the fine modern flour.

Buckwheat Cakes.—Buckwheat cakes are prepared from batter made by mixing buckwheat flour into a paste of the proper consistency, seeding it with yeast, and allowing it to remain in a moderately warm place until fermentation takes place. The proteins of buckwheat have some agglutinating power, and thus, when treated as above, make a cake capable of a considerable degree of aeration. Baking powders are often used as a substitute for yeast and permit of preparation in a few minutes instead of waiting for the fermentation above mentioned. The product made in this way cannot be considered so palatable or nutritious as the old-fashioned product. The batter is baked on a smooth hot iron or soapstone, polished and kept bright in order to prevent the sticking of the cake. The proper polishing of the iron is a better means of preventing sticking than greasing. The batter is poured over the smooth iron and is of a consistency to flatten out without help and to form a film over the baking iron, which produces a cake about one-fourth of an inch in thickness. The cake is to be turned as soon as the side in contact with the iron is brown. It is evident that in this baking process there can be no very profound change in the starch granules, but this does not appear to materially interfere with the digestibility of the product. Buckwheat cakes are eaten hot, usually with butter and sirup. Maple sirup, sorghum sirup, or cane sirup in a pure state are highly prized for use with buckwheat cakes. These sirups are both condimental and nutritious. Mixed sirups made of glucose, melted brown sugar, or molasses, or mixtures of all these bodies are more commonly furnished to the consumer than the pure sirup mentioned above. Honey is also used very extensively as a condimental flavor for cakes of this kind.

Adulterations.—There is probably no bread or cake making material which is subjected to more extensive adulteration than buckwheat flour. Much of what is sold as buckwheat flour may be regarded as imitations of that substance. Mixtures of rye flour, Indian corn flour, wheat flour, and other ground cereals are used as a substitute for buckwheat. There can be no objection from the hygienic point of view to such substitutes but the use of these mixtures under the name of buckwheat can be regarded in no other light than as an unpardonable fraud.

Detection of Adulterations.—There is rarely any mineral adulteration practiced with buckwheat flour and if so it is easily detected by incineration. Any content of ash, unless baking powder has been used, above 2 percent may be regarded with suspicion as indicating an admixture of some mineral substance. The cereal flours used for adulteration are readily detected by the microscope in the hands of an experienced observer. The field of the microscope has only to be compared with the microscopic appearance of genuine buckwheat starch in order to detect the added substance.

Buckwheat Starch.—The microscopic appearance of buckwheat starch is shown in the accompanying figure. The granules of buckwheat starch are very characteristic. They consist of chains or groups of more or less angular granules with a well defined nucleus, and without rings or with very faint rings. The contour of buckwheat starch is more angular than that of any other common cereal with the exception of maize and rice; it is this and the relative size which enable the observer to distinguish it from other starches. The size of the granules is quite uniform, varying usually only from 10 to 15 microns* in diameter. In so far as the angular appearance is concerned the granules of buckwheat starch have a general resemblance to those of maize and rice and oats, but a comparison under the microscope

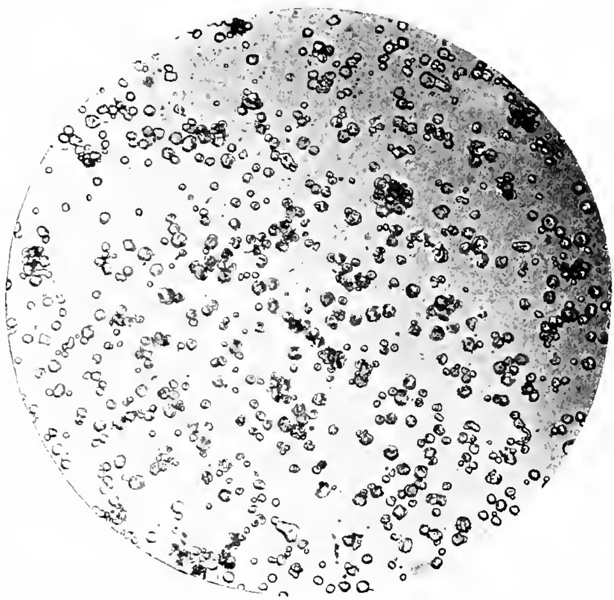


FIG. 23.—BUCKWHEAT STARCH. × 200.—(*Courtesy of Bureau of Chemistry.*)

of the three starches reveals lines of distinction which with a little practice would prevent the observer from drawing a false conclusion.

INDIAN CORN (*Zea mays*).

Next to wheat the most important cereal used as a human food in the United States is Indian corn. According to the magnitude of the crop, Indian corn is the leading cereal of the country. Statistical data on the production of Indian corn in the United States during 1909 are given in the following table.

Acreage,	108,771,000	
Yield per acre,	25.5	bushels
Production,	2,772,376,000	"
Value per bushel,	59.6	cents
Total value at farm,	1,652,822,000	dollars

*A micron is one thousandth of a millimeter.

Indian corn is universally employed as food throughout all parts of the country, but more especially in the South, where the daily dietary is rarely complete without one or more meals in which Indian corn is served in some form or other. Although it is grown much more extensively in the North than in the South, it is not so generally used as human food. Indian corn grows in all kinds of soil and produces, under favorable conditions, large yields in all parts of the country. It is the most important agricultural crop of many states, namely, Indiana, Illinois, Iowa, Missouri, and Kansas. It is planted in the late winter and spring in different parts of the country. The planting season varies from January in Florida to June in Maine and Minnesota and the earlier varieties will mature in 120 days.

Maize is a crop which requires an abundance of rainfall and a high temperature during the growing season. Maize is planted in rows about three and one-half feet apart and in hills of about the same distance apart, or it may be drilled between the rows so that one stalk grows a distance of about from nine inches to a foot from its fellows. It requires constant cultivation during the early period of its growth and a careful preparation of the seed bed. Good farmers give from four to seven cultivations to the growing crop. The field must be kept free of weeds and in good tilth to secure the best results.

Many hundreds of analyses of the maize kernel have been made, but a combination of them all in the following data may be regarded as typical of the Indian corn grown in this country.

Weight of 100 kernels,	38	grams
Moisture,	10.75	percent
Ether extract,	4.25	"
Protein,	10.00	"
Fiber,	1.75	"
Ash,	1.50	"
Starch and sugar, etc.,	71.75	"

The consideration of the above data shows that Indian corn is a ration in which the protein is rather low. In other words, the quotient of carbohydrates and fat divided by protein is rather large. It is a food product which is particularly well suited to furnish heat and energy and support a high degree of muscular exertion. For this reason it is a food product which is particularly well adapted to men engaged in hard manual labor.

Varieties.—There are many distinct varieties of Indian corn. Sturtevant has published a description of several hundred. These varieties are classified under various subspecies. The polymorphic species, *Zea mays*, according to Sturtevant, can be divided into a number of groups which, on account of their well defined and persistent characters, may be considered as presenting specific claims and may properly receive specific nomenclature. The grouping adopted is founded upon the internal structure of the kernel for cultivated varieties, and the presence of a husk to the kernel in the assumed aboriginal form.

Hence Sturtevant offers the names *Zea tunicata* for the husk-kernel forms, *Zea everta* for the popcorn, *Zea indurata* for the flint corns, *Zea indentata* for the dent corns, *Zea amylacea* for the soft corns, and *Zea saccharata* for the sweet corns.

Argument in favor of the specific claims for these groups is based primarily on the convenience thus attained; secondarily, on the absence or rarity of intermediate or connecting forms, so far as present data extend, and also on the antiquity of the separation. It seems almost certain that in the order of evolution (excluding from consideration the puzzling sweet corn group) progress

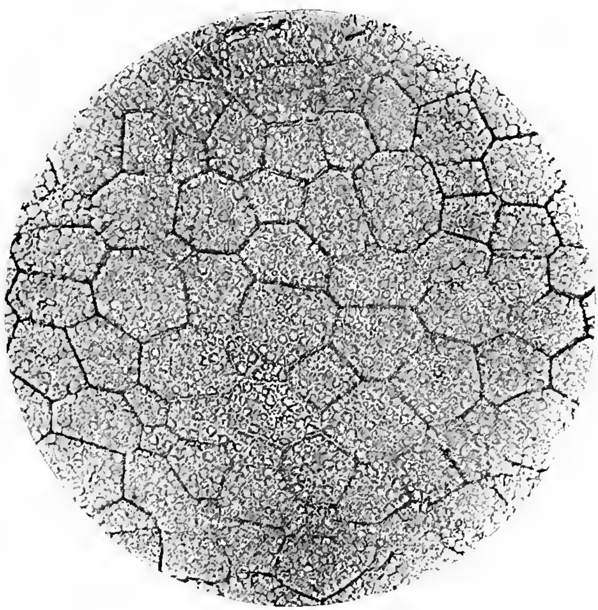


FIG. 24.—SECTION OF RAW POPCORN. × 150.—(*Courtesy of Bureau of Chemistry.*)
Shows cells with the small angular starch grains closely packed together within them.

has been from the pops, through the flints and the dents, to the softs. Certainly the soft corns in some of their varieties present a kernel that is larger, softer, and less fitted to the struggle with natural conditions than is the kernel from any of the other groups. Yet soft corns are the prevailing form in the mummy burials of Peru and of our Southwestern states. The popcorn, on the contrary, has stronger regerminative powers than have the other groups, is better fitted to contend against natural vicissitudes, and is the kind that has been reported as found growing wild in Mexico under the name of Coyote corn, *Zea canina* Watts.

Some of these subdivisions may not be accepted by botanists, but they are convenient for purposes of description. The principal field varieties which are grown are the flint corn, *Zea indurata*, and the dent corn, *Zea indentata.*

POPCORN.

This variety of maize is used very largely in the United States as a delicacy, and with sugar and cream as a dessert. It is a hard, small-grained variety which has the property, when heated, of exploding with a very great enlarge-

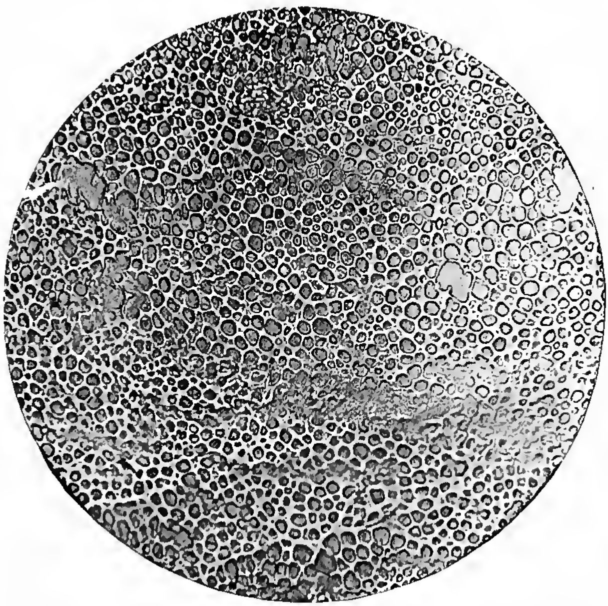


FIG. 25.—SECTION OF POPCORN IN FIRST STAGE OF POPPING, SHOWING PARTIALLY EXPANDED STARCH GRAINS AND RUPTURED CELL WALLS. × 150.—(*Courtesy of Bureau of Chemistry.*)

ment of the starch grain, producing a soft and very delicate edible material which is highly prized.

In the raw popcorn the starch grains are packed together very closely within the cells. When popping begins there is an expanding of the starch grains, producing a cavity nearly circular in form in each grain. This causes a rupturing of the cell walls, though fragments are plainly visible in the early stages. In the fully expanded or popped kernel the starch grains have expanded until each is about half or two-thirds as large as the original cells of the endosperm. The cell walls at this stage are practically obliterated as far as detection in a section is concerned. The exploding of the starch grains is influenced by the water content of the kernel. It must not be too wet nor too dry; about 10 or 12 percent is the proper content of moisture. These changes are beautifully shown in the accompanying microphotographs, Figs. 24, 25, and 26, by Mr. Howard, of the Bureau of Chemistry.

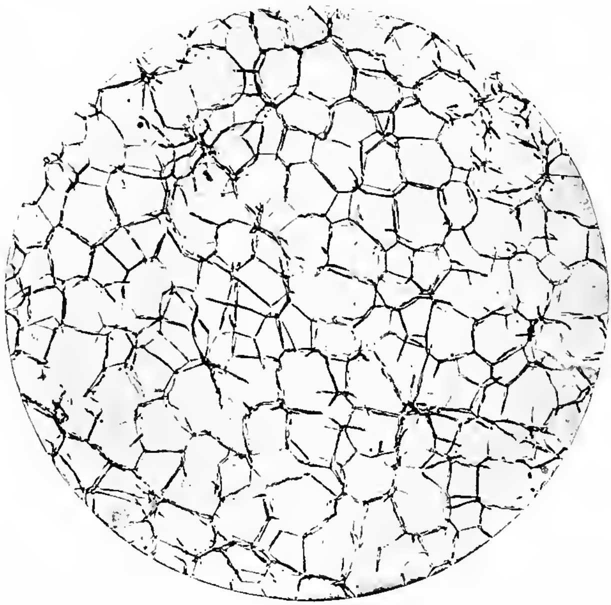


Fig. 26.—Section of Fully Popped Popcorn. × 150.—(*Courtesy of Bureau of Chemistry.*) The fully expanded starch grains are nearly half as large as the original cells in which they were contained.

SWEET CORN.

This is a variety of maize which develops a high sugar content and is eaten while the starch is yet soft, in other words, in an unripe state. It is a food product of immense importance in the United States, although almost unknown in Europe. The content of sugar varies from 5 to 8 percent in the fresh, soft kernel. The sugar which is present in the kernel rapidly disappears after the husking or removal from the stalk. In order to secure the maximum sweetness the corn should be cooked and eaten as soon as possible after removal from the stalk. Where it is not possible to do this it should be placed in cold storage after removal from the stalk and remain unhusked until it is ready for cooking. Green corn is universally eaten hot. It is usually cooked by boiling in water, although it may also be roasted before the fire. It has a high food value, and the composition of the grains of fresh, soft, green corn is shown in the following table:

Composition of Fresh Green Indian Corn:

Moisture,	73.00	percent
Starch,	13.50	"
Sugars,	6.00	"
Protein,	5.00	"
Crude fiber,	1.20	"
Ash,	.70	"
Fat,	.60	"

ize Proteins.—The proteins of maize are composed principally of two The two forms are differentiated by their behavior toward alcohol. first form constitutes the zein soluble in alcohol and the second the zein uble in alcohol. There are two other proteins in maize existing in smal tities which have been named myosin and vitellin, respectively. Ther so a third unnamed variety and small quantities of albumin.

ariation in Maize, under Different Climatic Conditions.—It is possi- that most of the varieties and subvarieties of maize are simply the existing dard varieties modified by changing environments. There are certain ditions of climate, soil, and distribution of rainfall which tend to produce large, starchy, soft grain, while other conditions tend to produce a small, hard ain richer in protein. The variations of importance are those of the carbohydrates and the protein, which are complementary, since as the protein rises the carbohydrates fall in relative proportion. There is also a marked variation in the carbohydrates, due to variety and climatic conditions combined. It is, for instance, the increase of the sugar at the expense of the starch that produces the body known as sweet maize eaten in the green state, as already described. Even in the sweet variety the relative proportion of sugar varies in different localities and under different conditions of growth.

Early Varieties.—There are certain varieties of maize which are of especial value on account of their early maturation. This is a property extremely valuable in the sweet variety of maize or that eaten in the green state, since it is important to get these varieties into the market as early as possible and to continue them as long as possible. This is secured by planting the early variety at the earliest date possible and planting later maturing varieties at intervals thereafter. By the selection of varieties of different periods of maturing it is possible in the climate of Washington to offer green corn from neighboring fields on the market from July until the advent of a killing frost which is usually the last of October or first of November. This gives a period of nearly four months during which the green corn may be delivered to the local market. Further south the period of supply is longer.

Canned Corn.—Immense quantities of green corn are grown for the purpose of canning in order to supply the market during the closed season. The canning industry for green corn is located chiefly in the north. In the eastern states the industry is of great importance, from Maryland to Maine. The northern-grown corns are often preferred as they are supposed to be sweeter and more palatable. In the central western states, northern Indiana, Michigan, Wisconsin, northern Illinois, and Iowa are the principal centers of the canning industry, although it is practised to a greater or less extent in almost all parts of the country.

Adulterations of Canned Corn.—Unfortunately in the canning process of corn additions have been made to the product which are of an objectionable nature. Chief among these is the use of bleaching agents such as sulfur in the form of burnt sulfur or of sulfite or bisulfite of soda or potash. These bleaching agents impart to the corn a white color which some consumers prefer, but at the expense of introducing a substance which must be regarded as deleterious to health. Still more objectionable is the practice of using saccharin instead of sugar as a sweetening agent. Saccharin is a coal tar product which has an intense, sweet taste, very persistent, and when used alone becomes disagreeable. A very small quantity of it is sufficient to impart a very sweet taste to the canned corn at a much less expense than could be secured by using the pure sugar. This form of adulteration is extremely reprehensible both because it deceives the consumer and adds a substance which by most hygienists is regarded as prejudicial to health. The bleaching agent and the artificial sweetener are wholly unnecessary. The manufacturers of sweet corn are expected to use the best and freshest and sweetest materials and cannot be excused for tampering with them in any way which either produces deception or injury to health.

Sugar added to make an ordinary corn taste like sweet corn is to be regarded as an adulteration unless its use is noted on the label.

Maize starch is also often added to sweet corn at the time of canning and this practice can only be regarded as an adulteration.

Detection of Adulterations in Sweet Corn.—*Test for Sulfurous Acid.*—To about 25 grams of the sample (with the addition of water, if necessary) placed in a 200-c.c. Erlenmeyer flask, add some pure zinc and several cubic centimeters of hydrochloric acid. In the presence of sulfites, hydrogen sulfid will be generated and may be tested for with lead paper. Traces of metallic sulfids are occasionally present in vegetables, and by the above test will indicate sulfites. Hence positive results obtained by this method should be verified by the distillation method.* It is always advisable to make the quantitative determination of sulfites, owing to the danger that the test may be due to traces of sulfids. A trace is not to be considered sufficient as indicating either a bleaching agent or a preservative.

Detection of Saccharin.†—Add from 25 to 40 c.c. of water to about 20 grams of the sample; macerate and strain through muslin; acidify with 2 c.c. of

* U. S. Dept. of Agri., Bureau of Chemistry Bulletin 107, Revised, page 187.

† *Ibid.*, page 182.

sulfuric acid (1 to 3) and extract with ether. Separate the ether layer, allow the ether to evaporate spontaneously, and take up the residue with water. If saccharin be present its presence will be indicated by the sweet taste imparted to the water. To confirm this test add from one to two grams of sodium hydroxid, and place the dish in an oil bath. Maintain the temperature of the oil at 250° C. for 20 minutes, when the saccharin will be converted into salicylic acid. After cooling and acidifying with sulfuric acid, extract in the usual way and test for salicylic acid. This test, of course, presupposes the absence of salicylic acid in the original sample. If salicylic acid is present in the original sample it must be removed before making the test for saccharin.

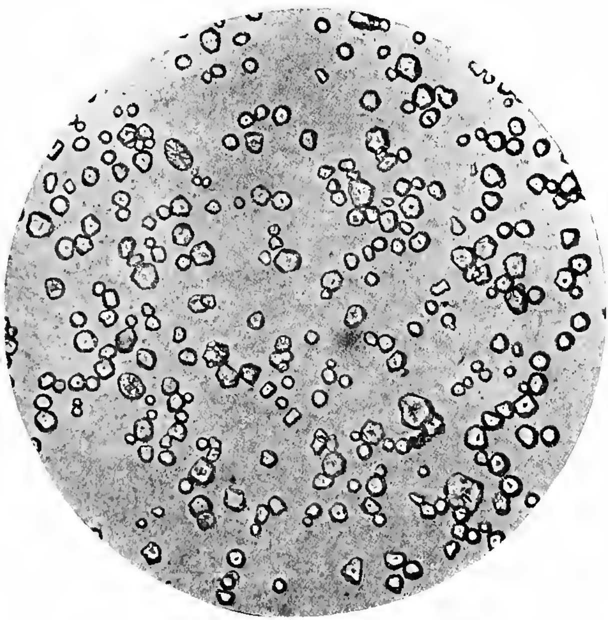


FIG. 27.—INDIAN CORN STARCH. × 200.—(*Bureau of Chemistry.*)

Starch of Indian Corn.—Maize starch has characteristics which enable it to be easily detected by the microscope. The granules of this starch are of a more uniform size than those of wheat, being from 20 to 30 microns in diameter. Occasionally very much smaller granules occur which probably are more of the original size and which have been arrested in growth by the ripening of the grain. The granules of maize starch are more or less polyhedral in form with round angles. The only common cereal starch which they can be mistaken for is rice, but they are generally larger than the granules of rice. Under the microscope with ordinary light they give only the faintest sign of rings but show in most cases a well developed hilum, which is at times star-shaped or like an irregular cross, while at other times it has the appearance of a circular depression. The maize starch granule is a type of the angular, as the wheat is of the sphere or spheroid form. The characteristic appearance of maize starch kernels is shown in the accompanying Fig. 27. Viewed with polarized light the starch grains of Indian corn present deep, well marked crosses, which divide each grain into four distinct parts as shown in Fig. 28. It is interesting to note that the angularity of maize starch is greatly influenced by the hardness of the kernels from which the grains are taken. The hard varieties, such as popcorn, have very angular grains while those from soft varieties have a great many almost spherical forms.

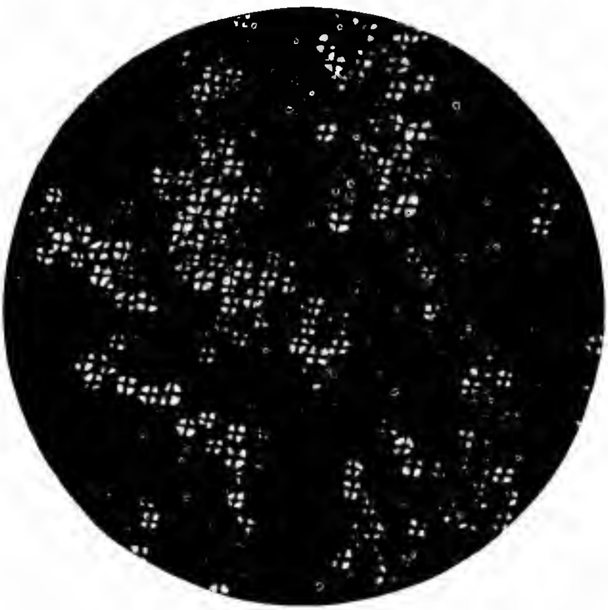


FIG. 28.—STARCH GRAINS OF INDIAN CORN, UNDER POLARIZED LIGHT. × 200.—(*Courtesy of Bureau of Chemistry.*)

Maize Flour (*Corn Meal*).—Formerly the maize kernel was ground between stones, bolted to remove the bran, and the maize flour or corn meal thus produced used directly as a human food. Modern milling operations have changed the method of producing maize flour so that not only is the outer bran removed but also, to a large extent, the germ itself, thus diminishing the quantity of fat in the prepared meal. This is notably true of the maize flour which is prepared for exportation. Leaving in the flour such a large quantity of fat tends to produce rancidity during shipment. To avoid any change of a deleterious nature which the flour may undergo during shipment, it is also frequently kiln-dried before being sent to foreign shores and even when intended for domestic consumption at points remote from the mill.

While this preparation of maize flour is doubtless important for transportation purposes, it impairs the palatability and nutritive value of the product. It is advisable to continue to have the maize flour prepared in the old-fashioned way and sent directly into consumption.

Method of Preparation.—One method of preparing the maize flour is as follows: The grains are broken into large pieces and dried with steam heat at a temperature of from 105° to 110° C. (221°–239° F.). The mass while still hot passes into a mill composed of two stones which revolve rapidly in opposite directions. The smaller portions of the meal, which have been reduced to a kind of gum by the high temperature, are separated by this process from the covering or the bran of the kernel. A small mass of the starchy matter leaves the mill in the form of small noodles, which are freed from any particles of bran by sifting. In this manner a mass is obtained which is quite free from fiber and fat.

The composition of maize meal prepared by the above process is as follows:

Moisture,	9.70	percent
Protein,	12.68	"
Ether extract,	1.19	"
Ash,	.60	"
Fiber,	.35	"
Starch, sugar, and dextrin,	71.48	"

This method of preparing maize meal is not used to any extent in this country, but is said to be commonly employed in Germany.

Composition of Maize Flour.—The color of maize flour depends upon the color of the corn from which it is produced,—it may be white or yellow. The starch granules when heated in water to 62.5° C. swell up and become deformed, except a few, usually the small ones, which resist the action of water at that temperature. The starch granules of maize flour under polarized light present a black cross, very marked and very distinct when the field is obscured. When viewed under polarized light with a selenite plate the starch grains of maize are colored red with a green cross or reciprocally, and this coloration is very brilliant.

As has already been said, the composition of Indian corn meal made by the old-fashioned method of grinding and removing only the bran is practically that of the whole grain itself.

The composition of degerminated maize meal (Indian corn flour) is shown by the following average data:

Moisture,	12.57	percent
Protein,	7.13	"
Ether extract,	1.33	"
Ash,	.61	"
Fiber,	.87	"
Starch and sugar,	78.36	"
Calories calculated on the moist meal,	3,837	

The above data show that the refined Indian corn meal has lost more than three-fourths of its fat, a large portion of its mineral matter, and also a very considerable proportion of its protein, due to the separation of the bran which is extremely rich in protein and the germ which is rich both in oil and protein. A mere glance at the data shows that this refined Indian corn meal is much less nutritious than the natural meal in so far as its content of tissue-forming bodies and its faculty to furnish heat and energy are concerned. In other words, the calories are very much lower than in the natural corn meal. This is another reason for urging our people to return to the consumption of the old-fashioned material.

The Adulteration of Indian Corn Meal.—Owing to the cheapness of Indian corn in so far as is known there is no adulteration practiced. The refined Indian corn flour itself is sometimes used as an adulteration for buckwheat flour, wheat flour, and other cereal flours, but has not itself been subjected to adulteration.

Corn Bread (*Indian Corn Bread*).—Corn bread is a very common diet among all classes of people in the southern states and also to a considerable extent in the north.

Owing to the lack of agglutinating powers of the nitrogenous constituents of Indian corn flour, corn bread cannot be aerated or raised, as is the case with wheat bread. It is often eaten in an unleavened state. It may be partially leavened by the usual agent, namely, yeast or a chemical baking powder. Two varieties of bread are very commonly used, namely, that made of white flour or meal and that made of yellow. There is apparently no difference in the nutritive values of these two kinds. Some consumers prefer the white loaf and some the yellow.

Composition of Indian Corn Bread.—The composition of bread depends upon whether the whole grain flour is used from which only the coarse bran has been removed by bolting or whether the decorticated and degerminated meal is used. In the first case bread is made richer in fat and protein and in the second case richer in starch. In the bread will also be found the materials used in its preparation, namely, salt, lard or other fats, milk, yeast, or baking powder residues. The best bread is made from the freshly ground flour of the whole grain from which only the outer covering, namely, the coarse bran has been removed. As offered at many of our hotels and some private houses, corn bread has been so manipulated as to lose a large part of its palatability, without any compensating improvement of its nutritive properties.

OATS (Genus *Avena*).

This cereal is an important food product, being used very largely in Europe, especially in Scotland, and also very extensively in this country as human food.

The chief use of oats is for cattle food, especially for horses. It is extraordinarily rich in its nutritive constituents and, therefore, is prized highly as a food in the building and restoration of nitrogen tissues, such as the muscles. The variety in common cultivation is *Avena sativa* L.

Oats are grown in almost every part of the United States, but chiefly in the northern and western portions. In the southern states the crop is planted in the late autumn or early winter. In the northern states it is chiefly a spring crop, being sown early in the spring as soon as the ground is in fair condition. The oat crop is one which requires a rather abundant and well-distributed rainfall. A spring drought is very detrimental to the growth of oats, much more so than wheat or rye. It is a crop which is well suited to be grown under irrigation.

There are many varieties of oats in cultivation, but in general characteristics they all correspond to one description. The husk adheres firmly to the grain, and when threshed the grain of a common variety of oat carries the first layer of husk or chaff with it. Oats, as bought in the market, therefore, consist not only of the kernel or grain but also of this outer, chaffy envelope. The magnitude of the crop in the United States is very great, but only an inconsiderable proportion of the whole is used for human food, and this chiefly in some form of oatmeal. The statistics of the crop grown in the United States during 1909 are given in the following table:

Acreage,	33,204,000
Yield per acre, bushels,	30.3
Total yield, bushels,	1,007,353,000
Price per bushel, cents,	40.5
Total value at farm,	$408,174,000

Ratio of Kernel to Hull.—Numerous examinations of unhulled oats show that the average percentage of kernel to hull for 100 parts is as 73 to 27. In the oats grown in the western states the proportion of kernel is relatively higher and in the southern states lower.

In the analytical process if the hull or chaff is ground with the grain the proportion of fiber or crude cellulose is very considerably higher than in the class of cereals ground without the chaff. The mean composition of unhulled kernels of oats of American growth is represented by the following table:

Weight of 100 unhulled grains,	2.92	grams
Moisture,	10.06	percent
Protein,	12.15	"
Ether extract,	4.33	"
Crude fiber,	12.07	"
Ash,	3.46	"
Starch and sugar,	57.93	"

A study of the above data shows that the flour of unhulled oats is rich in fat, fiber, and ash. The large percentage of fiber and ash is due to a great degree to the composition of the hulls or chaff. The fat or oil comes chiefly from the germ.

Composition of Hulled Oats.—Inasmuch as the chaff is always separated from the oat flour when the latter is to be used for human food, the composition of the oat in the hulled state is of greater importance to the present purpose than in the unhulled condition. The means of 179 analyses show the hulled oats to have the following composition:

Moisture,	6.93	percent
Protein,	14.31	"
Ether extract,	8.14	"
Crude fiber,	1.38	"
Ash,	2.15	"
Starch and sugar,	67.09	"

The removal of the hulls, as is seen, and the partially dried condition of the grain in the above analysis increases the percentage of other ingredients. The protein and fat are especially large in quantity. Oatmeals may be regarded as the richest of the cereal flours, both in protein and in oil.

The Protein of Oat Kernels.—There are three principal products in the oat kernels characterized by their different degrees of solubility, namely, protein soluble in alcohol, protein soluble in dilute salt solution, and protein soluble in alkali. The protein soluble in alcohol constitutes about 1.25 percent of the whole grain, the protein soluble in dilute salt solution about 1.5 percent, and the protein soluble in alkali the remainder, viz., 11.25 percent. The protein of oats has very little agglutinating power and, therefore, oat flour is not suitable for making bread, or rather it is very little used for that purpose.

Oat Products.—As has been intimated before, the principal oat products, as far as food is concerned, are the various forms of oatmeal commonly classed as breakfast foods. These products are prepared in various forms of agglutination and physical texture but if made from genuine oats, as there is little cause for doubt, they have essentially the same composition and nutritive power. It is doubtful if there is any preparation of oatmeal any more nutritious or palatable than the plain oat grain properly cooked. The forms in which the oat products are offered to the public are perhaps more convenient for use and in some cases by reason of heating and preparation require less trouble, but otherwise they apparently have no advantage over the simple product.

The mean composition of a number of oat flour products is shown in the following table:

Moisture,	7.66	percent
Protein,	15.48	"
Ether extract,	7.46	"
Crude fiber,	1.20	"
Ash,	1.29	"
Starch and sugar,	67.61	"

In the dry substance:

Protein,	16.77 percent
Ether extract,	8.08 "
Crude fiber,	1.38 "
Ash,	1.94 "
Starch and sugar,	73.20 "
Calories,	4,875

It is evident from the above average analysis that the products examined are made from the whole kernel without the removal of the germ but with a very careful removal of the hull and bran. The composition of these products compares very favorably with the typical composition of the kernel itself.

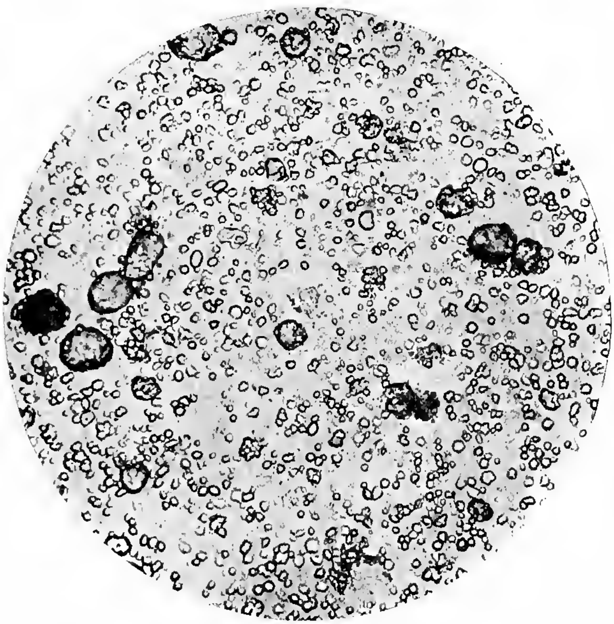


FIG. 29.—OAT STARCH. × 200.—(*Courtesy of Bureau of Chemistry.*)

These data show the high nutritive value of these oat products, both in respect of fat and protein.

Adulterations.—There are very few adulterations of oatmeal. Fortunately the price of this cereal is such that the admixture of other cereals would not be profitable. Doubtless such admixtures have often been made but evidently, from the examination of the products upon the open market, they are not very frequent. The characteristic appearance of oat starch is shown in Fig. 29.

Oat starch grains average about 10 microns in diameter. There are usually present some grains of somewhat oval shape, which assist in identifying oat products when present. The starch granules also have a tendency to agglutinate into masses of varying size, as shown in the photograph.

Detection of Adulterations.—The adulteration of oatmeal with the flour of other cereals can easily be detected by the use of the microscope. Oat starch when highly magnified presents a peculiar cellular structure of pentagonal character which might be compared to the effect produced by grinding a large number of faces upon a precious stone. This peculiar appearance is caused by the tendency of the starch granules in oats to become compacted in large masses. The appearance of the separate granules and also the compact aggregate are shown in the figure on the preceding page. The large aggregated masses are of different sizes, ranging from .02 to 1.2 millimeters in length. These masses are usually broken up by grinding or pressure and, therefore, are not found in very great abundance in the commercial oatmeal. When separated into single granules these are found to be irregular in outline, due to the compression to which they have been subjected, more or less pentagonal in structure, and from .015 to .02 millimeter in diameter. The starch granules do not show any very marked characteristics under polarized light and have neither lines nor hilum. The above statements can easily be verified by any one who can operate an ordinary microscope, but before attempting to detect adulteration a careful examination of starch granules, prepared by the investigator himself, should be made.

RICE (*Oryza sativa*).

Rice is one of the most important food cereals. It furnishes a large part of the food of the inhabitants of China and Japan. It is a food rich in starch and poor in protein, and furnishes, therefore, heat and energy, and is well adapted for the nourishment of those engaged in hard labor or who undergo extreme physical exertion. The cultivation of rice is rapidly extending in the United States, especially in Louisiana and Texas. The statistical data relating to the rice crop for 1909 are as follows:

Acreage,	720,225	acres
Production,	24,368,000	bushels
Yield per acre,	33.8	"
Price per bushel,	79.4	cents
Total value at farm,	19,341,000	dollars

The adulteration of rice is confined to coating it with talc, paraffin, and glucose. The object of this treatment is to give a better appearance to the grain and to protect it from the ravages of insects. The use of indigestible substances such as talc and paraffin is scarcely justifiable. The starch granules of rice have distinctive properties which enable them to be readily recognized under the microscope, as shown in Fig. 30.

The rice starch grains are polygonal in form and have sharp angles. The grains vary in size from 2 to 10 microns, though the latter size is seldom reached, the most of the grains being about 6 microns. The hilum is seldom visible. The grains occur in the rice kernels mostly in groups of a considerable number of the individual grains forming starch masses of ovoid or angular form.

RYE.

This is the source of the principal supply of bread in many European countries, but is not extensively used in the United States except among our citizens of foreign birth. It is also extensively used for making whisky. Rye belongs

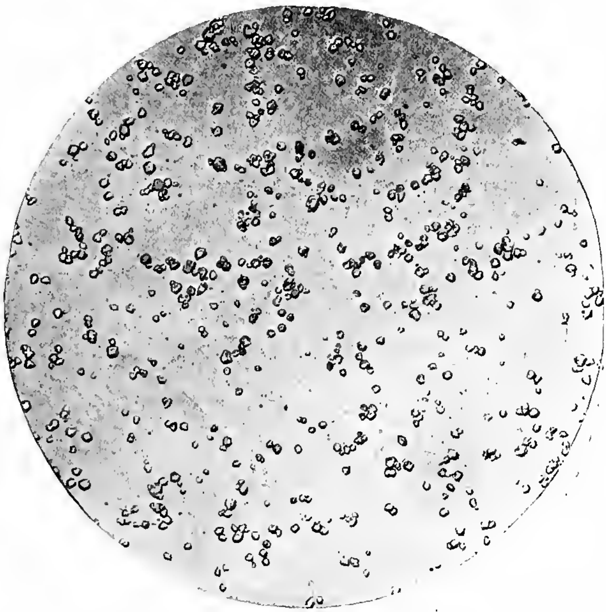


FIG. 30.—RICE STARCH. × 200.—(*Courtesy of Bureau of Chemistry.*)

to the genus *Secale*. Only one species (*Secale cereale* L.) is commonly cultivated, but this species has a great many different varieties or races. According to the time of sowing there are two great classes of rye, namely, that planted in the autumn or early winter and that planted in the early spring, generally known respectively as winter and spring rye. This is one of the hardiest of cereals, and grows well in all locations where wheat and other common cereals flourish. The area planted in rye in the United States in 1909 and the quantity harvested are given in the following table:

Acreage,	2,006,000	
Yield per acre,	16.4	bushels
Production,	32,239,000	"
Price per bushel,	73.9	cents
Total value at farm,	23,809,000	dollars

Composition of Rye.—From a study of many hundreds of analyses of rye of American origin the following table may be given as approximating the composition of a typical American rye:

Weight of 100 kernels	2.50	grams
Moisture	10.50	percent
Ether extract	1.50	"
Protein	12.25	"
Fiber	2.10	"
Starch and sugar	71.75	"
Ash	1.90	"

The percentage of moisture in American grown rye is usually less than that of European origin. The American rye, also, has smaller kernels as a rule

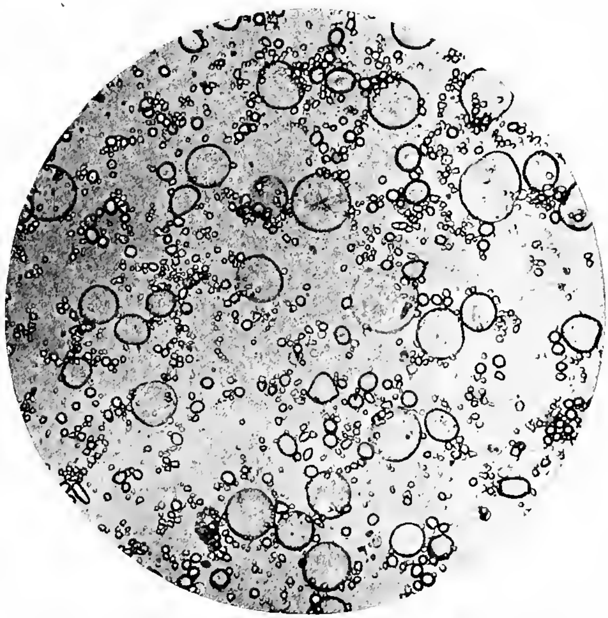


FIG. 31.—RYE STARCH. × 200.—(*Courtesy of Bureau of Chemistry.*)

than that of foreign growth. In the content of protein the American samples of rye are fully equivalent to those of foreign origin, and in their mean composition, except as noted above, do not differ greatly from that of standard varieties collected abroad.

Protein of Rye.—As is the case with other cereals more than one nitrogenous constituent exists in the rye. Three of the principal ones have been separated and named as follows: leucosin, gliadin, and edestin. Other proteins belonging to the globulin, albumin, and proteose family are also found in small proportions. The gliadin of rye resembles in its chemical and physical properties the gliadin of wheat. There is, however, in the rye no protein compound corresponding to the glutenin of wheat, and, therefore, rye flour does not form a gluten similar in quality to that of wheat, although it comes nearer to doing so than any other cereal. The gliadin of rye is soluble in alcohol, the leucosin of rye is soluble in water, and the edestin is soluble in a salt solution.

In a typical sample of American rye there will be found about 5.16 percent of gliadin, 2.27 percent of edestin and proteose, 0.55 percent of leucosin, and 3.14 percent of protein soluble in salt solution.

Adulteration of Rye Flour.—Rye flour is frequently adulterated by the admixture of flours of other cereals. Real rye flour is distinguished by the character of the starch granules, as shown in Fig. 31.

Rye starch grains are lenticular in form, and the largest grains are of about 50 microns diameter. They average somewhat larger than wheat starch grains and are characterized by many of the large grains having a fissure in the form of a slit, cross, or star, which is rare in wheat and barley. The rings and hilum are indistinctly seen in some of the grains.

Rye Bread.—This bread may be made leavened or unleavened, since the analogy in the property of its protein to that of wheat renders the leavening of rye bread somewhat more easy of accomplishment than that of the other cereals, with the exception of wheat.

Rye bread made of pure rye flour has a dark color, sometimes almost black. It is often baked long in advance of the time of eating and keeps well, is highly nutritious, and is the staple bread of many European countries.

A partial rye flour bread is made by mixing rye flour with other flours, such as wheat, barley, Indian corn, etc., and this is the kind which is commonly used in this country and in many portions of Europe where the light-colored breads are preferred to the dark.

The large consumption of bread made from rye and Indian corn indicates that even if the supply of wheat should become limited there is no reason to fear a famine of bread. It would be easy to substitute bread made wholly or in part of Indian corn and rye for that made wholly of wheat and thus to supply practically any demand for bread which the increasing population of the earth may make.

WHEAT (Genus *Triticum*).

In respect of human nutrition wheat is the most important of the cereals. It is grown in the temperate regions of almost every country, but does not flourish in tropical or subtropical countries.

In the United States the wheat is divided in respect of the period of its growth into two great classes, namely, winter or fall planted wheat and spring or spring planted wheat. Winter wheat is usually planted from September to November and spring wheat from the last of March to the last of April.

In this country wheat is not cultivated, that is, there is no cultivation of the soil after seeding. The soil is, however, plowed and harrowed before planting. In the winter wheat regions the harvesting is in the month of June, though in the southern localities it comes somewhat earlier and in the more northern localities may extend into July. In the spring wheat regions the harvesting is from the last of July to the middle or end of August. The statistics of wheat grown in the United States during 1909 are as follows:

	Winter.	Spring.
Acreage,	28,330,000	18,393,000
Yield per acre (bushels),	15.8	15.8
Total yield (bushels),	446,366,000	290,823,000
Total value at farm,	$459,154,000	$270,892,000
Price per bushel (cents),	102.9	93.1

All the different varieties of wheat which are now known are cultivated. The simplest form, namely, the one grain wheat is the only one which grows wild, and the origin of the other varieties of wheat is unknown.

Botanists recognize three species, namely—Species 1, one grain wheat (*Triticum monococcum* Lam.); species 2, Polish wheat (*Triticum polonicum* L.); species 3, common wheat (*Triticum sativum* Lam.). All of these species are distinct, especially the third one, of which the most valuable variety is the common wheat, *Triticum vulgare* Vill.

The quality and properties of wheat depend more upon the environment in which it is grown than upon the species to which it belongs. There is perhaps no other field crop in which the environment, namely, condition of the soil, temperature, precipitation, etc., makes a greater difference than in wheat. In general, the environment and the species together produce two kinds of wheat as far as milling and bread making are concerned, namely, the soft or starchy wheat and the hard or glutinous wheat. In the first variety there is a larger percentage of starch in relation to the content or protein matter than in the second. Taking the wheat as a whole its average composition is shown in the following table:

Weight of 100 kernels,	3.85	grams
Moisture,	10.60	percent
Protein,	12.25	"
Ether extract,	1.75	"
Crude fiber,	2.40	"
Ash,	1.75	"
Carbohydrates other than crude fiber,	71.25	"
Dry gluten,	10.25	"
Moist gluten,	26.50	"

In regard to protein American wheat, as a rule, is quite equal to that of foreign origin. This is an important characteristic when it is remembered that both the milling and food value of a wheat depend largely upon the nitrogenous matter which is present. It must not be forgotten, however, that merely a good percentage of protein is not of itself a sure indication of the milling value of a wheat. The ratio of gluten to the other protein constituents in a wheat is not always constant, but it is the gluten content of a flour on which the bread making qualities chiefly depend.

Gluten.—The principal part of the protein in wheat is known as gluten. Gluten as such does not exist in the wheat but is formed when the pulverized wheat, that is, the wheat flour, is mixed with water by the union of two elements in the wheat, namely, gliadin, which is soluble in dilute alcohol and forms nearly half of the whole protein matter of the wheat kernel, and glutenin, a compound insoluble in water, dilute salt solutions, and dilute alcohol and which is quite as abundant as gliadin in the wheat kernel. In fact, the gliadin and the glutenin together make the whole of the protein, except a little over one per cent.

There are three other forms of protein, as pointed out by Osborne, in the wheat kernel, making altogether nearly 1½ percent of total protein content. The average quantity of these compounds in the protein of wheat is as follows.

Constituents:

Globulin,	0.70	percent
Albumin,	0.40	"
Proteose,	0.30	"
Gliadin,	4.25	"
Glutenin,	4.35	"
	10.00	

Starch in the Wheat Kernel.—The most abundant constituent of the wheat kernel is the starch. The appearance of wheat starch is shown in the figure. Wheat starch grains ordinarily show the rings and hilum in a few cases only under the most favorable conditions, though there are sometimes cases where the striations are quite distinct. The granules of starch vary greatly in size, being from 5 to 10 microns in diameter. There are, in fact, two kinds of granules in wheat starch, one having the appearance under the microscope of irregularly rounded particles in sections like a circular disk, and the other of elongated particles with a distinct hilum, as shown in Fig. 32. The appearance of the granules under polarized light is shown in Fig. 33.

Wheat starch is not very commonly used for commercial purposes but is highly prized for some things, especially in the sizing of textile fabrics. The germ in wheat is particularly rich in oil and the bran or outside covering in protein. The common idea that the bran is composed mostly of silicious matter is wholly erroneous. On the contrary the bran is a highly nutritious food, and the objection to it for human food is mostly of a mechanical nature.

Adulterations.—Wheat grains are never adulterated but they may sometimes contain dirt and foreign seeds, due to the growth of some body in connection with the wheat itself.

Standards.—Wheat, commercially, is sold under three standards, namely, one, two, three. The difference is an arbitrary one and not founded upon any chemical data but wholly upon the physical appearance, degree of moisture, and freedom from extraneous admixtures.

Wheat Products.—The principal product of wheat is flour. The milling process for wheat is highly interesting both from a chemical and technical point of view, but cannot be described in full in this manual. The old-fashioned milling of wheat, namely, pressing between stones and separation of the flour by bolting has been almost entirely superseded by the modern milling with metal rollers.

Altogether nearly a hundred different products are made incident or final

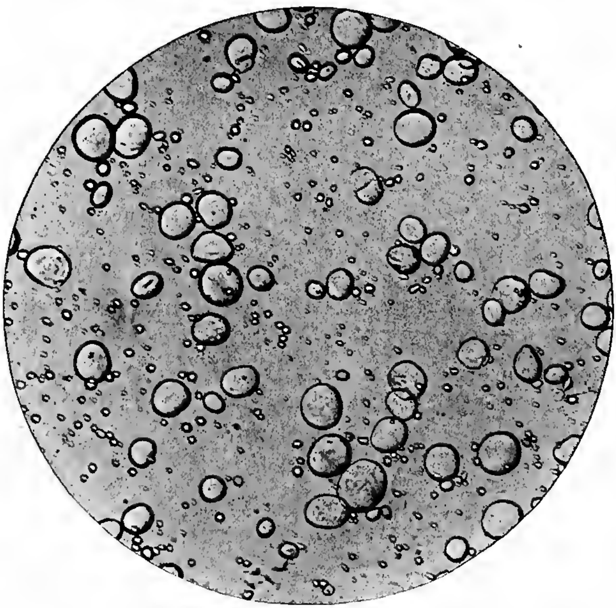


FIG. 32.—WHEAT STARCH. × 200.—(*Courtesy of Bureau of Chemistry.*)

to the milling of wheat. Only those products, however, which are used for human food interest us at the present time.

Chief Varieties of Flour.—The highest grade of wheat flour is known usually by the term "patent"; a lower grade is known as "bakers' flour" and a third as low grade flour. A barrel of flour weighs 196 pounds and requires about 258 pounds of wheat for its manufacture. The whole product from the 258.35 pounds of wheat is shown in the appended table.

In general it may be said that about 75 percent of the weight of the wheat is obtained as merchantable flour of some kind, about 60 to 70 percent being good grade or straight flour. About 24 percent of the weight of the wheat is obtained as cattle food and about 1 percent is lost during the process of manufacture.

Product.	Pounds.	Percentage.
Patent flour,	149.37	57.82
Bakers' flour,	29.13	11.28
Low grade flour,	17.50	6.77
Total flour,	196.00	75.87
Bran,	45.56	17.64
Shorts,	9.80	3.79
Screenings,	4.99	1.93
Waste,	2.00	0.77
Total weight,	258.35	100.00

Special Names of Flour.—In addition to the classification above mentioned other names are used in many commercial senses for flour. These additional

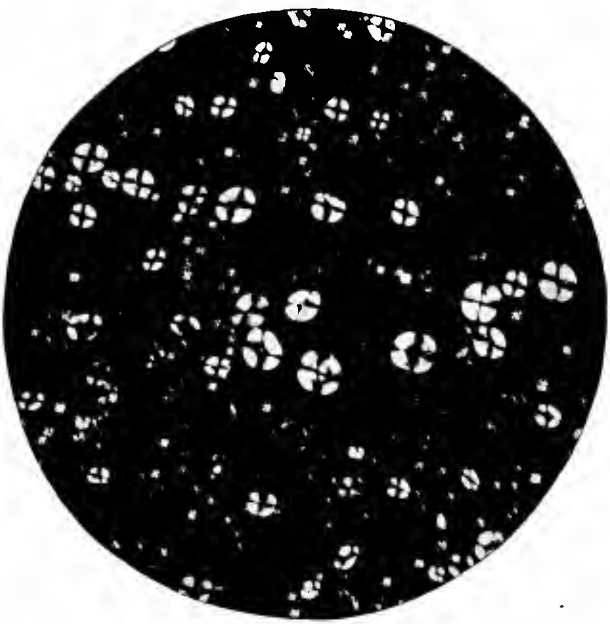


FIG. 33.—WHEAT STARCH UNDER POLARIZED LIGHT. × 200.—(*Courtesy of Bureau of Chemistry*).

names are "family," "red dog," "blended," gluten, etc. Many flours are also named after the name of the mill or locality or bear simply fanciful names.

Graham Flour.—This term was originally applied to the coarse, unbolted flour which was made by grinding the whole wheat. The name, therefore, should be applied to all flour made from well grained wheat, ground, and unbolted. Most of the flours however, which are sold nowadays as graham flours are produced by a more or less perfect bolting process. From the above it is seen that true graham flour will contain practically the same constituents as the wheat kernel itself and in the same proportion and have the same composition as wheat.

Entire Wheat Flour.—This name would naturally carry the idea of a flour corresponding to the graham flour above mentioned. It is, however, a misnamed trade-mark for a flour produced in a special manner which consists in the removal of the outer or purely branny covering of the grain. "Entire wheat" flour, therefore, contains all the ingredients of wheat grains, save those which are found in the outer branny covering.

Gluten Flour.—This is a name applied to a flour which is produced by removing the greater part of the starch from ordinary flour. It is especially recommended for the use of diabetic patients. Unfortunately, the name is very commonly applied to flours made from wheat containing a little higher percentage of protein than the ordinary and sometimes even to an ordinary wheat flour. A gluten flour should contain not less than 35 percent of protein.

Mixed Flour.—The act of Congress of June 13, 1898, defines mixed flour and imposes a tax upon the manufacture, sale, importation, and exportation of that article. The maximum tax laid upon mixed flour is 4 cents on a barrel of 196 pounds. The total number of barrels of mixed flour returned for taxation for the fiscal year ending June 30, 1909, was 195; half barrels, 83,648; quarter barrels, 30,067; eighth barrels, 35,789. The total quantity of mixed flour returned for taxation during the year was 8,215,167 pounds. The above data show that the amount of mixed flour offered for sale is a very small part of the total flour manufactured in the United States. It may be that there is a great deal of flour mixed and sold in violation of the law since it is quite impossible in the inspection of the stores to supervise all the transactions of business deals in flour; especially is it believed that rye flour and buckwheat flour are often adulterated by mixing with them the flour of other cereals. This adulteration is not one which is at all injurious to health but is simply practiced for the purpose of making a rye or buckwheat flour look whiter or because the added flours are cheaper than the real rye or buckwheat.

Properties Affecting the Commercial Value of Flour.—Aside from its nutritive properties wheat flour has a commercial value depending upon its color and texture and upon the gluten which it contains. The character of gluten also varies largely in different varieties of wheat and in wheat grown in different localities. A chemical examination will not always tell the bread making properties of a flour, and the character of the bread itself depends often quite as much upon the skill of the baker as upon the flour which is used.

In cases where loaves are sold by weight, a flour with a high percentage of tenacious gluten is often preferred, since it permits of the forming of loaves containing a maximum percentage of water. With a flour rich in gluten it is not difficult to make a palatable loaf which does not bear any evidence of an excess of water, containing as much as 40 percent of moisture. The baking of bread is an art which is most successfully practiced by professionals, and the American method of home bread making does not always lead to the happiest results.

The ideal flour for bread making is one which contains a sufficient quantity of gluten to make a porous and spongy loaf, but not one which permits an excessive quantity of moisture to be incorporated in the loaf itself.

Average Composition of Different Varieties of Flour.—Analyses of a great number of samples of different varieties of flours lead to the following data, which may be accepted as a very close approximation of the average variety of different grades of flour offered upon the American market:

Name of Flour.	Moisture.	Proteids N × 6.25.	Proteids N × 5.70.	Moist Gluten.	Dry Gluten.	Oil.	Ash.	Starch N × 6.25.*	Starch N × 5.70.*	Crude Fiber.	Calories.
	Perct.	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	
Patent flour, ...	12.77	10.55	9.62	25.97	9.99	1.02	0.44	74.76	76.14	0.21	3,858.0
Bakers' and family flour, . .	11.69	12.28	11.20	34.70	13.07	1.30	0.57	73.87	74.98	0.22	3,929.6
Common market flour, . .	12.28	10.18	9.28	24.55	9.21	1.30	0.61	75.63	76.53	0.28	3,882.5
Miscellaneous flour, ...	12.73	10.45	9.52	26.80	10.22	1.08	0.49	75.23	76.15	0.25	3,846.3
Self-raising flour, . . .	11.45	9.75	8.89	26.97	9.65	0.70	4.45	73.66	74.51	0.21	3,719.3
Gluten flour, ...	12.99	13.30	12.13	39.68	14.84	1.05	0.55	72.11	73.28	0.32	3,891.1

Separation of Gluten.—The character of a wheat flour, as has already been intimated, is measured largely by the quantity of gluten which it may contain. The separation of gluten may be accomplished by any one, even without a chemical training, by a little practice. It is, therefore, one of the tests for the value of a wheat flour which can be easily and generally applied. The principle of separation of the gluten rests upon the fact that when wheat flour is moistened and kneaded into a sticky mass it may be washed with pure water with constant kneading until nearly all the starch has been removed from the mass. Meanwhile only that portion of the protein is removed which is soluble in the water and the gluten which is formed by the process of kneading remains as a sticky mass. When this moist mass is kneaded and rolled until all the moisture is taken out of it that can be removed in this way, it may be weighed and the proportion of moist gluten in the sample determined. It may then be placed in an oven and dried, and then the proportion of dry gluten secured. The following method is one which is easily applied: Place 10 grams of the sample in a porcelain dish and moisten with from 6 to 7 cubic centi-

* In the first of these columns the starch is calculated by difference, assuming the protein to be the quantity of nitrogen present multiplied by 6.25. and in the second column the figure is obtained in the same way, using 5.70 as the protein factor.

meters of water, knead, and allow to stand for an hour. Work into a ball, being careful that none of the material adheres to the dish. Holding the mass in the hand knead it in a slow stream of cold water until the starch and all soluble matter are washed out. Place the ball of gluten thus formed in cold water and allow to stand for one hour; remove from water, press as dry as possible between the hands, roll into a ball, and weigh in a flat-bottomed dish. After weighing, place the ball of moist gluten in the drying oven for twenty hours; cool and weigh.

Gluten Tester.—A simple test for determining the approximate per-

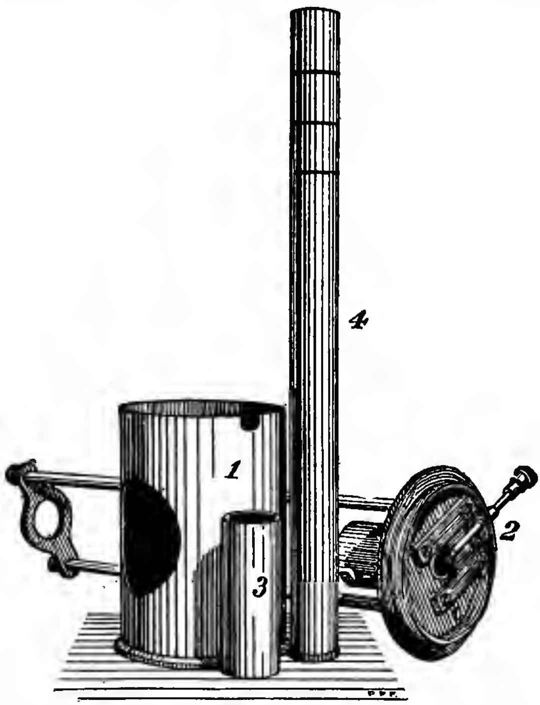


FIG. 34.—KEDZIE'S FARINOMETER SHOWING THE PARTS.—(*Bulletin 13, U. S. Dept. of Agriculture.*)

centage of gluten in flour may be used, based upon the principle that the viscosity of dough is a measure of its practical gluten content. The name applied to a gluten tester is farinometer.

A convenient form of farinometer devised by Kedzie is shown in the accompanying figure. It is patterned somewhat upon the plan of Jago's viscometer. The instrument is shown in parts in Fig. 34. The instrument as in use is exhibited in Fig. 35. Parts shown in Fig. 34 are as follows: No. 1 is the stand or support of the parts. No. 2 is the cap of

No. 1, and discloses the half-inch opening (half closed by the slide) through which the dough is forced by the pressure of the rod No. 4. The slide by which this opening is closed is plainly shown; also the socket for holding No. 3. No. 3 is a brass tube 3 inches high and 1 inch internal diameter, with a small knob to fit into the notched opening in the side of the socket seen in No. 2, to hold No. 3 firmly in place. No. 4 is a steel rod $\frac{15}{16}$ inch in diameter and 12 inches long, with a thin brass cap 1 inch in diameter, beveled slightly so that the front edge fills the barrel of No. 3 without friction, and is yet dough-tight. Near the top the rod is marked into inch spaces.

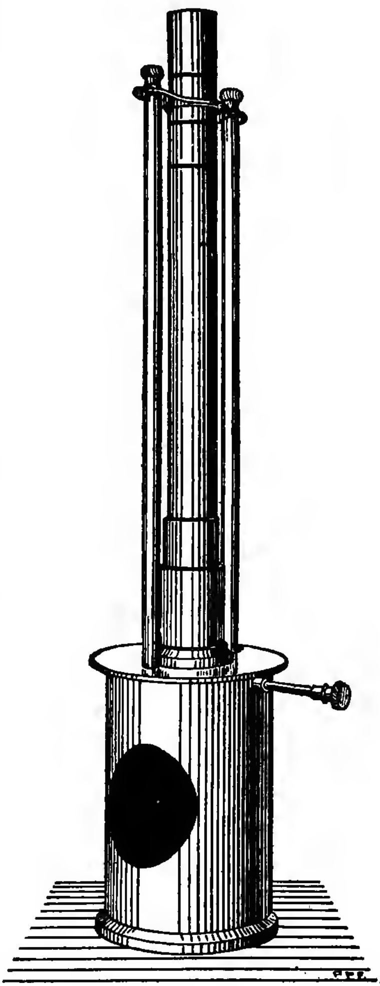


FIG. 35.—KEDZIE'S FARINOMETER IN USE.—(*Bulletin 13, U. S. Dept. of Agriculture.*)

In using the farinometer two points are considered:

1. The water-absorbing power of a flour, or the percentage of water it will take up to form a dough of a certain consistency.

2. The viscosity of such dough, or its resistance to change of form under a uniform force; *e. g.*, the length of time in seconds required to force a cylinder of dough 1 inch high through a hole one-half inch in diameter under the pressure of a vertical steel rod 13 inches long and weighing $2\frac{1}{2}$ pounds avoirdupois.

Bleaching of Flour.—Formerly flour was extensively bleached for the purpose of making an inferior article resemble a superior one. By this means a greater percentage of the flour produced can be rated as of first quality. The oxids of nitrogen developed by electrical discharges are the principal bleaching agents employed, and add to the flour a substance which may be injurious to health. Under the Food and Drugs Act the bleaching of flour for interstate commerce has practically ceased.

Adulteration of Flour.—The adulteration of wheat flour is not practiced to any extent in this country. The most common adulteration arises from grinding with wheat foreign seeds and other foreign matter, rust, smut, etc., which may be present in the grain. Other adulterations are the mixture with wheat flour of the starch or flour of maize and other cereals. The adulteration with any form of terra alba or white powdered earthy substance is exceedingly rare. Although some attempts have been made to introduce such adulterations in this country they have not reached any commercial success. The adulterations, with the exception of those with white earthy powders, are most readily ascertained by microscopic examination for foreign matters and other varieties of starch than grow naturally in the wheat.

Standard.—The United States standard for flour is as follows:

Flour is the fine, sound product made by bolting wheat meal and contains not more than thirteen and one-half (13.5) percent of moisture, not less than one and twenty-five hundredths (1.25) percent of nitrogen, not more than one (1.0) percent of ash, and not more than fifty hundredths (0.50) percent of fiber.

Graham flour is unbolted wheat meal.

Whole wheat flour, entire **wheat** flour, improperly so called, is fine wheat meal from which a part of the bran has been removed.

Gluten flour is the product made from flour by the removal of starch, and contains not less than five and six-tenths (5.6) percent of nitrogen and not more than ten (10) percent of moisture.

Age of Flour.—The freshly ground flour is most highly esteemed by many consumers on account of palatability and freedom from all danger of mold and ferments. Older flours are likely to lose flavor, become moldy and infested with weavil and other insect pests. The last-named evils are avoided by the use of wheat containing no fungus, none of the eggs of the weavil, nor of other insects, and enclosing the freshly ground flour in packages not accessible to infection. Even then it is advisable to consume the flour as soon as convenient after the milling process. Many manufacturers and experts contend that flour is improved by keeping for a certain length of time, and this contention is based on the assumption that the flour assumes a lighter color and improves in flavor on keeping. There is of course a certain limit to improvements of this kind.

Substitutes for Flour.—Wholesome ingredients are used in part instead of flour in bread making, and when that fact is clearly made known the admixture of these substances with flour is not considered an adulteration. Bread which is made of an admixture of Indian corn meal with flour or rye flour with flour or other cereal products is well liked by many people. Potatoes are also used very often in bread making. Acorns, buckwheat, and other farinaceous and oily substances are also employed. The admixture of inert substances with flour merely to increase the bulk and weight of the loaf, even if stated, cannot be regarded as other than an adulteration.

In times of famine such admixtures are sometimes made in order to increase the size and weight of the loaf. Such substances are known in times of famine as "hunger bread." Finely ground straw, bark, the hulls of nuts, etc., are often used for this purpose. These bodies practically have no nutritive value and serve no useful purpose except to deceive the eater respecting the quantity of bread he consumes.

BREAD.

The term "Bread" when used alone is understood in this country to apply to bread made from wheat flour or some form of wheat. If made from other cereals a prefix is used to distinguish this fact, as Indian corn bread, rye bread, etc. The term bread includes also the materials which are used necessarily therewith in the ordinary process of baking. Thus, the term bread would apply to a loaf which contains not only the wheat flour as the base and chief part of its mass but also the yeast or other leavening agent employed, together with salt, lard, or butter used in its preparation. The presence of these bodies, used in the sense above described, is not regarded as an adulteration. The term "bread," however, is not to be used to include those other forms of nutriment made from wheat flour in which condimental substances, especially sugar, are used to such an extent as to give the dominant taste of the condiment or condiments employed. Thus, the ordinary cake of all descriptions, tarts, puddings, and other edible substances made largely from wheat flour, but to which the condiment or condiments impart a distinct taste, are not included under the term bread.

In the generic sense the term bread may be used in the largest signification to signify food in general.

Varieties of Bread.—In general all forms of bread may be divided into two great classes, leavened and unleavened. By far, the greater quantity of bread consumed belongs to the former class. Unleavened bread is used chiefly for certain religious festivals, in the form of biscuits or in certain varieties of Indian corn bread such as hoe cake, johnnie cake, etc. Of the leavened bread there are two distinct classes, namely, bread which is baked and eaten cold and bread which is consumed hot from the oven. Bread intended to be consumed cold is generally eaten within twenty-four or forty-eight hours from the time of making though some varieties may be kept for an indefinite period. The use of hot bread is not commended by hygienists though it is difficult to see why, when properly made, the consumption of a hot roll should be regarded as injurious. The apparent injury which may result therefrom is probably due to the larger quantity eaten on account of greater palatability than is the case with cold bread. That variety of bread which is baked so as to present a maximum of crust and made of flour which gives a tough consistency to the loaf is most highly regarded both for palatability and nutritive purposes. This form of bread is improperly called French or Vienna rolls in this country.

Unleavened bread is particularly advisable for use in emergency rations for marching soldiers, in logging camps, etc. This bread is compact, comparatively free of moisture and has a high nutritive value. The leavened bread may be divided into distinct classes in respect of the leavening agent employed.

Class 1 is bread in which the leavening agent is yeast. Class 2 is bread in which the natural ferments residing in the flour or wheat are utilized for the leavening agent as in the making of that variety known as salt rising bread. Class 3 includes that form of bread in which the leavening is secured by chemical reagents mixed with the dough. Class 4 includes that variety in which a leavening reagent such as carbon dioxid or air is mechanically incorporated with the dough during the kneading process.

Unleavened bread is also divided into several technical forms. The first class includes the biscuit of commerce, sometimes incorrectly called crackers, and intended to be used soon after preparation. The second class includes biscuits which are intended for long storage and transportation. The third class includes wafers and other delicate forms of unleavened bread for special use. Class 4 is the unleavened loaves which are made most frequently from Indian corn meal and intended to be eaten while still hot. Class 5 includes any miscellaneous unleavened loaves or cakes made in various ways and for different purposes.

In nearly all forms of unleavened bread made from wheat flour the dough is thoroughly beaten, and mechanically mixed or kneaded, in order to make it lighter in color and more crisp and hard after baking.

Yeast.—Bakers' yeast is one form of the ordinary yeast ferments or a mixture thereof producing alcoholic fermentation under proper conditions. All flour contains a certain quantity of sugar which is easily fermented. By the action of the yeast upon this sugar carbon dioxid and alcohol are formed. The particles of carbon dioxid become entangled in the gluten of the wheat flour when it is mixed into a dough and thus make the mass spongy and light. When placed in the oven to be baked these minute particles of carbon dioxid expand still more and produce additional lightness and sponginess of the loaf. The yeast may be propagated from one mass of dough to another, may be used in a moist state or, as is very commonly the case, manufactured in large quantities, and sold either moist or more commonly in a partially dried and pressed cake.

Spontaneous Ferments.—All cereals contain ferments of a character to produce alcoholic fermentation spontaneously under proper conditions. It is possible even to ferment dough by seed from one loaf to another or by developing a spontaneous fermentation. This method is quite a common one in the rural districts, and all bread made in this way is known as salt rising bread. It may be made according to the following receipt:

A quarter of a pint of fresh whole milk is slowly heated to near the boiling point, but not allowed to boil. This process will sterilize the milk and prevent the development of a too rapid lactic fermentation in the subsequent processes. The heated milk is added to a quantity of maize meal sufficient to make with the milk a stiff batter, and the whole is thoroughly mixed. The vessel containing the batter is wrapped with paper and then with a heavy flannel cloth, and kept in a warm place at a uniform temperature of about blood heat for several hours, until fermentation is fully established and the batter assumes a definite sour odor. At this point a teaspoonful of salt is stirred into a pint of blood-warm water and into this a sufficient quantity of high-grade wheat flour is stirred to make a moderately stiff batter. This is thoroughly mixed with the sour mass obtained by the previous fermentation and the mixture exposed for from three-fourths to one hour to a blood heat as before. If the fermentation has been well conducted the mass will now be in a sufficiently active state to secure a proper porosity of the loaf. The salt rising thus prepared is mixed with a wheat flour dough made with warm water in sufficient quantities to make from four to six loaves, the whole mass well-kneaded, molded into loaves and put aside at a temperature of blood heat until the fermentation has proceeded far enough to make the loaf light and spongy. The loaf is then baked in the ordinary way.

Chemical Aerating Agents.—In this country a very common method of aerating bread is practiced, based upon the use of certain chemical reagents which when mixed in the dough set free carbon dioxid. These reagents are known as baking or yeast powders and are especially prized by reason of the fact that it is possible with their aid to prepare in a few moments a light spongy loaf or roll which would require from 10 to 24 hours to make by the ordinary fermenting with yeast. The principal objection to the use of baking powder lies in the fact that the residues arising from the chemical reaction are necessarily left in the loaf. While these residues may not have any specific or poisonous properties they increase the quantity of mineral matter in the bread, and this mineral matter is in the inorganic state and as such does not take any part in the process of nutrition. It can only be regarded as a waste product, burdening, to that extent, the excretory organs of the body.

Constituents of Baking Powder.—The essential constituents of baking powder are a carbonate of some kind and an acid reagent capable of decomposing this carbonate and setting the carbon dioxid free. The common carbonate of a baking powder is bicarbonate of soda. The classification of baking powders rests upon the acid elements which they contain. They may be classified as follows: (1) Cream of tartar baking powder, in which the acid constituent is cream of tartar which is known chemically as acid potassium tartrate. Other forms of tartaric acid may be used in baking powders of this class but they are not common. (2) Phosphate powders, in which the acid constituent is phosphoric acid usually in the form of the acid phosphate of lime. (3) Alum powders in which the acid constituent is alum or some form of aluminium sulfate, usually the basic sulfate of alumina.

The acid and basic constituents of these powders may be kept in separate containers and mixed together at the time of making the dough. A more common form is to use them in such a way that until they mix with the dough they do not exert any notable effect upon each other. For instance, perfectly dry bicarbonate of soda and perfectly dry acid potassium tartrate may be mixed together and kept for quite a while without any notable decomposition of the bicarbonate taking place.

In order to render any such possible action minimum in its effect it is customary to add to the mixture a small quantity of starch, milk sugar, or some other diluent. These materials tend to keep apart the particles of acid and base and render it possible to make a mixture of them which may be kept for a long while without any notable loss of leavening power. When a cream of tartar baking powder is mixed with dough the moisture of the dough gradually dissolves the two ingredients and in this state a chemical reaction occurs between them. The carbon dioxid is set free as a gas, commonly known as carbonic acid. The mineral substance which results is a tartrate of sodium and potassium that is a union of tartaric acid with potash and soda. This compound is commonly known under the term of Rochelle salts. If there be a sufficient quantity of water in the bread to allow the Rochelle salts to crystallize in the usual way a portion of the water becomes incorporated with the salt. Two teaspoonsful of a tartrate baking powder leave a residue of about 11 grams (165 grains) of crystallized Rochelle salts in the loaf.

Phosphate Powders.—As has already been said, the acid constituent of phosphate powder is chiefly acid phosphate of lime In this case the acid phosphate of lime decomposes the bicarbonate of soda with the production of carbon dioxid and leaves a residue consisting of a mixture of sodium and lime phosphate. If in two teaspoonsful of phosphate powder there are approximately 16 grams (250 grains) there is formed a crystallized residue, about an equal weight of phosphate of soda and lime, which is left in the loaf.

Alum Powders.—Perhaps by far the largest part of baking powders used contain alum in some form as the acid constituent. Formerly the common substance known as alum or burnt alum was employed but in late years an aluminium basic salt known as basic sulfate of aluminium has largely succeeded the old form of alum. When the reaction takes place in the dough between these two constituents of alum baking powder there is formed an equivalent quantity of sulfate of soda and hydroxid of alumina if the acid constituent be basic aluminium sulfate.

The quantity of residue left in the loaf if two teaspoonsful of baking powder be used is about 11 grams (165 grains).

Harmfulness of Baking Powder Residues.—The question of the harmfulness of the residues left by the various forms of baking powder is one which has been of much interest to the hygienist and physician. It is not claimed in any case that these residues are beneficial. The principal question which has been discussed is which of them is the least harmful. This is a question which it is not proper to enter into in this manual. It might, however, not be out of place to say that the use of chemical reagents for leavening bread is not as advisable as the use of the ordinary fermentation. It would be better, evidently, if all people used more yeast bread and less baking powder rolls. At the same time the utility and convenience of baking powder cannot be denied, and this is a factor which must be taken into consideration in the general discussion and final resolution of the question.

Character of Alum Residues.—Every one is agreed that the substance known as alum, namely, the sulfate of alumina in conjunction with another mineral or base, such as soda, potash, or ammonia, is not a desirable constituent of food products. In the manufacture of baking powders containing alum an effort is made to so balance the constituents that when the reaction is completed no undecomposed alum remains. If this condition is secured in every instance the materials which remain in the bread are not alum but the residues above mentioned, consisting of aluminium hydrate, and sulfates of soda, potash, or ammonia.

The residue of chief importance is the hydroxid or hydrate of alumina, which is the form in which the alumina itself should appear when a complete reaction like that defined above takes place. When the hydroxid of alumina is dried and especially when ignited it is converted into an oxid of alumina which is highly insoluble in water and only slightly soluble in a very dilute acid solution. The claim is made by the manufacturer of alum powders that the aluminium residue which is formed is insoluble in the digestive juices and therefore cannot produce any effect usually ascribed to the soluble salts of aluminium. It is important that the conditions which obtain in the baking of bread should be such as to produce this highly desirable result. The temperature of the interior of the loaf during baking does not rise much above that of boiling water, although the exterior temperature, which is sufficient to produce the browning of the crust, is very much above that temperature. It is evident that as long as any considerable proportion of water remains in the loaf it will be difficult to raise the interior of the loaf to the temperature just mentioned, and if this were done the caramelization would take place throughout the whole loaf. Unfortunately, from a scientific point of view the investigation of this subject has not been always undertaken under conditions which are wholly beyond criticism. Many of the investigations have been in the interest of rival baking powder companies, and it is very desirable that this matter should be undertaken in a wholly unbiased way and conducted in such a manner as to lead to results which all will accept. Chemical and physiological investigations, which have even as a remote object the promotion of the sale of one compound and the repression of the sale of another, lose at the outset much of that claim upon the public confidence which such investigations made from a purely scientific point of view should have.

General Statement.—In respect of the use of chemical leavening agents in general it may be said that they introduce an extraneous product into the bread which is not likely to promote the health and which, therefore, on general principles should be excluded. On the other hand, large experience has shown that the consumption of bread made by these leavening agents does not produce any general effect upon the public health which is noticeable. This, it is understood, is not any valid argument in favor of the process. It must also be acknowledged that a fermentation of a bread with yeast also introduces extraneous matter into the food, viz., alcohol and congeneric products of fermentation, and hence this process may be open to a certain extent to the same objection as the one above. It is too early yet to formulate definite principles either of inclusion or exclusion of these products, and the purpose of this manual is secured when the general character and effects thereof are briefly outlined.

Composition of Bread.—Because of the many different methods of bread making which are practised it is not possible to give in a chemical form an analysis which would do more than represent in general the character of the bread in common use. For instance, the quantity of water which is found in bread varies greatly and the nature of bread itself must be influenced by the character of the flour from which it is made. The flour depends upon the quality of the wheat used in its manufacture. Hence the same brand of bread prepared in the same way and baked in the same manner must necessarily vary in composition from season to season and even from day to day. It must be understood also that it is a very common custom in the United States to use milk in the mixing of dough, and thus a food product is introduced which of itself is not of constant character. Some bakers use whole milk, others skimmed, and others sour milk.

A very good formula for mixing dough for bread making consists in using the following proportions of ingredients mentioned:

Flour,	2,000	grams
Whole milk,	500	"
Water,	650	"
Salt,	25	"
Yeast cake,	10	"

When properly leavened and kneaded and baked these quantities of materials will make a loaf of bread weighing 2750 grams.

Average Composition of Bread.—In the following tables are given the average composition of bread of different classes. Class 1 is composed of loaves of the so-called Vienna or French type; Class 2 consists of what is known as home made bread or bread baked at the home and not in the bakery; Class 3 consists of bread made from graham flour; Class 4 consists of bread made largely of rye flour; Class 5 is a second collection of home made bread which may be very properly compared with Class 2; Class 6 consists of bread of miscellaneous origin bought on the open market. The data given represent the mean composition of numbers of samples (Bull. 13, Bureau of Chemistry):

	Moisture.	Protein.	Ether Extract.	Fiber.	Ash.	Starch and Sugar.	Salt.	Calories.
Class 1.	Perct.	Perct.	Perct.	Perct.	Perct.	Perct.	Perct.	
	38.71	8.09	1.06	.62	1.19	53.72	.57	. .
In the dry substance, . .		13.23	1.73	.97	1.95	83.10	.93	4458
Class 2.								
	33.02	7.24	1.95	.24	1.05	56.75	.56	. .
In the dry substance, . .		10.80	2.91	.36	1.55	84.75	.84	4497
Class 3.								
	34.80	8.15	2.03	1.13	1.59	53.40	.69	. .
In the dry substance, . .		12.51	3.13	1.74	2.29	82.06	1.07	4434
Class 4.								
	33.42	7.88	.66	.62	1.84	56.21	1.00	. .
In the dry substance, . .		11.86	1.02	.95	2.79	84.36	1.50	4395
Class 5.								
	36.16	7.10	1.14	.26	1.06	54.53	.58	. .
In the dry substance, . .		11.17	1.75	.41	1.68	85.41	.92	4395
Class 6.								
	34.41	6.93	1.48	.30	1.00	56.18	.49	. .
In the dry substance, . .		10.59	2.21	.46	1.53	85.66	.76	4401

A Typical American High-grade Yeast Bread.—In conjunction with the actual analyses given above it is of interest to combine as many analytical data as can be conveniently secured for the purpose of determining what the average composition of a high-grade typical yeast bread is. This comparison leads to the following composition:

Moisture,	35.00	percent
Protein,	8.00	"
Ether extract,	.75	"
Starch and sugar,	54.45	"
Fiber,	.30	"
Ash,	1.50	"

Of the ash mentioned in the above analysis .50 percent may be ascribed to the natural mineral ingredients of flour and 1 percent to added salt.

The chief variations from the typical composition of bread made from high-grade flour are found in the moisture and ether extract. The moisture may rise above 40 percent in breads made of flour rich in gluten or sink to 30 percent or under when flour of an inferior gluten content is employed. The quantity of ether extract depends chiefly upon the amount of milk which is used in the making of bread and the amount of fat employed either in the bread itself or in greasing the pan in which it is baked. There is great difficulty in extracting a fatty body which has been mixed with a glutinous material like flour. The analytical data, therefore, do not represent in the ether extract all the fat naturally present in the flour plus that added in the making of dough or in baking.

The quantity of moisture in bread may also be determined largely by the time of baking and the temperature of the oven. A bread baked for a long while at a low temperature will be much drier than a bread baked quickly at a high temperature. The high temperature solidifies the exterior of the loaf so as to make it difficult for the interior moisture to escape. By quickly baking the bread the temperature of the interior does not reach so high a temperature as in an oven with a low temperature and a long-continued heat.

Standard for Moisture.—The quantity of moisture in bread of standard quality in the District of Columbia may not exceed 31 percent.

The average temperature of the baking oven is about 240° C. (464° F.).

Quantity of Sugar in Bread.—The quantity of sugar found in fermented bread is always less than that present in the flour, added in milk, or otherwise introduced in the preparation of the dough. The sugar disappears largely under the influence of the fermentation due to the yeast.

Quantity of Ash.—The quantity of ash in bread is uniformly higher than the content of mineral matter in the flour. This is due to the addition of common salt which is uniformly employed in all bread, and in the case of bread made from baking powder the retention of the mineral residues in the loaf increases to that extent the content of ash. With the exception of the ash, the ether extract or fat, the sugar, and the dry material of bread correspond in quantity to the same materials in the flour from which it is made, except the loss due to the caramelization of the crust.

Acidity of Bread.—The development of the lactic acid ferments is important in regard to hygienic conditions and to palatability. Flour contains practically no acid in a free state, and the acidity of bread is itself due to the changes which take place in its preparation under the influence of the ferments therein. Bread baked in the usual manner after the yeast ferments have exerted their activity shows the presence of acetic acid, lactic acid, and other acids and salts. The acidity of bread adds to its palatability and also, doubtless, to its digestibility. Bread, containing, as it does, a large percentage of protein, is digested in an acid medium. The natural acidity of bread, therefore, must be regarded as beneficial.

Comparative Nutritive Properties of Indian Corn Bread and Wheat Bread.—There is a widespread opinion that the products of Indian corn are less digestible and less nutritious than those of wheat. This opinion amounts to a conviction in most European countries, where the products obtained by the milling of Indian corn are not regarded as fit for human food in an unmixed state. The above opinion, it appears, has no justification either from the chemical composition of the two bodies or from recorded digestive and nutritive experiments.

A study of the analytical data of the whole grain shows that in so far as actual nutrition is concerned the maize is fully as nutritious as wheat. In respect of its content of fat Indian corn and its direct products easily take precedence of all the other cereals, with the exception of hulled oats. In round numbers Indian corn flour or bread made therefrom contains twice as much fat or oil as wheat, three times as much as rye, twice as much as barley, and nearly as much as hulled oats. In regard to digestible carbohydrates, that is digestible starch, sugar, dextrin, and fiber, Indian corn flour possesses a higher content than hulled oats and almost the same content as wheat. In regard to digestible protein Indian corn has nearly the same quantity as the other leading cereals, except oats. What it lacks, however, in its quantity of protein in so far as nutrition is concerned is more than made up in its excess of fat.

Comparative Digestibility and Nutrition of Wheat and Indian Corn from Experiments Made in South Dakota Station, Bulletin 38.—Pigs were fed with Indian corn and wheat, or rather the ground Indian corn and ground wheat, and it was found that pound for pound there was a greater gain in the case of Indian corn flour than wheat. For 100 pounds of flour fed the average gain with Indian corn was 21.83 pounds and where wheat flour was used 20.79 pounds. These experimental data show that in regard to nutritive properties Indian corn flour cannot be considered inferior to wheat flour. Indian corn bread is particularly well suited for persons engaged in hard manual labor. A ration which is composed largely of Indian corn products and oatmeal is found to be particularly valuable for those engaged in lumbering, harvesting sugar-cane, etc.

Indian Corn Flour Pudding.—Various forms of pudding are prepared from Indian corn flour. Among the most important is that known in the New England States as hasty pudding and in the west and south as mush. A simple method of preparing Indian corn pudding, hasty pudding, or mush is to stir into water, very slowly, the Indian corn flour in such a way as to avoid the formation of lumps. The flour should be sifted into the water either cold or at boiling temperature and the mixture vigorously stirred meanwhile. By this means a thin, uniform paste is secured which is allowed to cook slowly until quite thick in consistence and until all the starch granules are thoroughly disintegrated. The product is improved by allowing to stand for several hours at near the boiling point after the cooking is finished, provided precautions are taken not to allow the mass to become too solid. This product is eaten hot with butter, milk, or cream, or is much prized when allowed to cool, cut into thin slices and fried. A very important dish for the children of working people and farmers of the south and west is mush and milk, namely the product above mentioned eaten with skim milk. This mixture forms a palatable and wholesome diet. Various other forms of pudding are made into which Indian corn enters to a greater or less degree.

Composition of Biscuits.—The composition of a biscuit or dry unleavened bread does not differ essentially from that of the ordinary bread except in the content of moisture. The biscuits are usually baked in thin cakes or loaves which become heated throughout and sometimes caramelize throughout a large part of their substance. This favors the expulsion of the greater part of the moisture which the dough originally contained. The average composition of biscuits is shown in the following data:

Moisture,	7.13	percent
Protein,	9.43	"
Ether extract,	8.67	"
Fiber,	.47	"
Ash,	1.57	"
Salt,	.99	"
Starch and sugar,	73.77	"

In the dry substance:

Protein,	10.18	percent
Ether extract,	9.33	"
Fiber,	.53	"
Ash,	1.70	"
Salt,	1.08	"
Starch and sugar,	78.79	"
Calories,	4,755	

The above data show that biscuits vary in composition from bread chiefly in their content of moisture and fat or oil. The moisture, as is noted, is very low, while the quantity of fat which the biscuit contains is from 8 to 10 times as great as that contained in flour from which they are made. The salt content and the mineral ingredients of the biscuit are often higher than in bread or flour. Inasmuch as a large quantity of fat and salt are used commonly in the manufacture of biscuits the presence of these bodies cannot in any sense be regarded as an adulteration. In forty-eight samples examined only four were free of notable quantities of added fat. In one case over 16 percent of fat was found, and as it has been shown that all the fat which is added is not extracted by ether it is evident that in this case an amount of fat equal to 20 percent of the weight of the flour may have been used.

It appears, from a study of the composition of biscuits, that it is advisable to use them as a relish or delicacy for eating with cheese, etc., in ordinary daily life, while they become almost a necessity in some form or other in the preparation of emergency rations for marching armies, on shipboard, in logging camps, etc. It is not advisable to employ them in the daily diet to the exclusion of bread. Their nutrient contents have, in comparison with bread, a lower coefficient of digestibility, due largely to the added fat.

Amount of Sugar Lost in Fermentation.—The total quantity of sugar and other carbohydrates lost in fermentation amounts to about 2 percent of the weight of flour used. Sometimes it is much greater and sometimes less than this. The nutritive value of the product is diminished in proportion to the extent of the loss of sugar. The carbon dioxid produced during fermentation has no food value, and the alcohol is largely lost in the form of vapor during the process of baking. About half the loss is due to carbon dioxid and half to alcohol. The alcohol, although lost mostly during the baking, serves a useful purpose,—in the expansion of the vapor it aids the carbon dioxid in making the bread more porous. The hydrolysis which takes place in baking converts some of the starch to dextrinoid or saccharoid

FIG. 36.—COMPARATIVE APPEARANCE OF BREADS OF DIFFERENT KINDS.

conditions. It is evident that from 6 to 8 percent of total starch present in the flour is changed during the fermentation and baking into more or less soluble forms.

Texture and Size of Loaves Made from Different Kinds of Flour.—The variations in bread and size of loaves made from different kinds of flour when the conditions of fermentation and baking are the same depends upon the texture and quantity of the gluten material in the flour. The difference in the appearance and size of loaves is shown by a photograph of the cross-sections of three loaves of bread in Fig. 36.

It is seen that the loaves made from graham flour and entire wheat flour to the left in the illustration, are somewhat coarser in structure and are smaller in size than the one made from the same quantity of standard patent flour, shown to the right.

MACARONI.

The preparation of wheat flour of a high glutenous character and molded into various forms, usually tubes, cylindroids, or fine shreds, is known in the trade under various names such as noodles, spaghetti, and macaroni. An examination of a number of these bodies shows them to have the following average composition:

Moisture,	9.66	percent
Protein,	12.02	"
Ether extract,	.42	"
Crude fiber,	.56	"
Ash,	.78	"
Starch and sugar,	77.12	"

In the dry substance:

Protein,	13.33	percent
Ether extract,	.47	"
Crude fiber,	.62	"
Ash,	.86	"
Starch and sugar,	85.34	"
Calories,	4,428	

These bodies, it is seen, do not have a composition very different from that of a first-class bread except in their content of moisture and protein. They are made from various kinds of wheat, especially hard wheat which forms a tenacious gluten product well suited to molding into the different forms which these bodies have. Their nutritive value is practically the same as that of good wheat bread of the same moisture content.

Domestic Macaroni.—The introduction of varieties of wheat with the properties suitable for making macaroni has been thoroughly exploited by the Department of Agriculture. The macaroni wheat grown as a subvariety is known botanically as *Triticum durum.* The durum wheats are not regarded as of equal value to the ordinary wheats for general milling purposes and command a lower price. The French name is Blé dur and the German name is Hartweizen. The wheat of this subspecies grows rather tall, having broad, smooth leaves of a whitish green color and a very hard cuticle. The heads are comparatively slight in most varieties, compactly formed, and occasionally very short. All the durum wheat is bearded and the beards are exceptionally long. The kernels are hard and glassy, often partly translucent. They are generally yellowish white in color, occasionally inclined to red, and the grains are generally rather large. In other aspects this wheat resembles barley and for this reason in Germany it is often called Gerstenweizen. The general appearance of these wheats both in the field and in the individual heads is shown in the accompanying figures.

Macaroni wheats are well adapted to semi-arid regions; in fact it may be said that they are the product of such an environment rather than adapted

Fig. 37.—A Field of Durum Wheat.—(*Courtesy of Bureau of Plant Industry.*)

FIG. 38.—DROUGHT-RESISTANT MACARONI WHEATS (HEADS AND GRAINS).
1, Kubanka; 2, Nicaragua; 3, Velvet Don; 4, Black Don; 5, Wild Goose.—(*Bulletin No.3, Bureau of Plant Industry, U. S. Dept. of Agriculture.*)

to it. For this reason they are wheats which are able to resist continued dry weather and high temperature. These wheats do not grow well in acid soils but flourish best in an alkaline soil of fine texture and well supplied with humus and the necessary plant foods. The largest quantity of macaroni wheat is grown in east and south Russia. These wheats have given very good results in the semi-arid regions of the United States. The appearance of the wheat as it grows in the field is shown in the accompanying plate.

The domestic macaroni is now made in many factories in the United States and there is a continually increasing demand for the domestic article. The hardiest varieties of wheat are used in the manufacture of this article in the United States, especially the hard Kansas winter wheat.

Composition of Domestic Macaroni.—In the table below is given the mean composition of twenty samples of macaroni of domestic origin, made from domestic wheat. In the second column is given the mean composition of five samples of imported macaroni.

	Domestic Product.	Foreign Product.
Moisture,	10.27	10.32
Fat or ether extract,	.40	.35
Crude fiber,	.49	.53
Protein,	11.61	12.27
Starch and sugar,	76.52	76.10

Preparation of Flour for Macaroni.—The term Semolina or Semola (Italian) or Semoule (French) is usually applied to the flour used in the manufacture of macaroni. In the United States the flour which is used is obtained by selecting the hardest wheat and preparing the flour in the usual manner. In France and Italy the preparation of semolina is accomplished in separate mills. The devices for grinding are essentially the same as those for producing the best grade flour, the main difference being that the wheat is moistened slightly before grinding and the flour is less fine than ordinary baking flour.

Evidently very slight changes in the method of milling would enable the ordinary mill to produce a fine grade of macaroni flour either from the macaroni wheat or from any very hard glutinous wheat grown in the United States.

Manufacture of Macaroni.—As practiced in the best districts of Italy, macaroni is manufactured according to the following method:*

The durum wheat is ground into semola and sieved to remove the starchy part of the grains and leave the clear, light amber, or glutinous part. Three or four grades of quality are made, and these depend on the size of the sieve meshes.

The semola is put into a special iron mixer, shaped like an old-fashioned artillery mortar, except that it is square instead of cylindrical, and furnished in the bottom with special screw-shaped fans with which to stir the paste

*Fairchild, U. S. Dept. Agr., Bureau of Plant Industry, Bulletin 25.

or dough. Boiling water is added to the semola and the dough is mixed for about seven minutes. The mass is then put on a flat, circular kneading board and kneaded by two sharp-edged parallel beams which rise and fall as the table turns and press into the dough as they descend. A few minutes of kneading are sufficient and the homogeneous dough is then put into the cylinder and the piston descends upon the mass, forcing it in strings slowly through the perforated plate at the bottom. Fifteen minutes are required to convert the gallons of dough into thousands of feet of yellow macaroni. The yellow color is produced by the use of saffron or of a coal tar dye of which a very small quantity is put into each batch of dough. This is a reprehensible practice.

As soon as the strings of fresh paste which issue continually from the die are of the proper length they are cut and thrown over a reed pole and carried into the sunlight, if the weather is fair, or into sheltered terraces, protected by curtains from the rain, if the weather is unfavorable. On bright days the strings of macaroni are exposed to the sunlight only two hours. They must be dried out only slightly before being cellared for the night in dungeon-like underground vaults similar to the Bavarian beer cellars.

For twelve hours or more the poles of macaroni are kept in these damp places, until the dough has become moist and pliable again and the strings have lost the brittleness that the exposure to the sunlight has given them. From the cellars the poles are carried to shaded storehouses open on all sides to the air but not lighted from above. Here, in great masses of millions of strings, they hang for several days, from eight to twenty being required, depending upon the dryness of the atmosphere. According to the statements of a manager of a factory this process of drying is necessary to give to the brittle paste a horn-like toughness and fit it to withstand the rough handling to which it will be subjected without breaking into small pieces.

In all this simple process the one point at which bacteria might have a chance to play a rôle is in the first drying, cellaring, and subsequent slow drying in the shade. The theory that the water is responsible for the flavor must rest, it seems to the writer, on other than bacterial grounds, for from the appearance of the tank which supplied the hot water the inference is easy that the water is chalybeate, for the tank was incrusted with iron.

ROLLS.

The term rolls is applied to bread, usually leavened with yeast, whether it is eaten warm or cold. The term biscuit is generally but improperly used in this country for hot bread made with baking powder. The composition of rolls varies greatly with their method of preparation. Those made with yeast have practically the same composition as ordinary fermented bread, while those made with a baking powder or with exceptionally large additions of milk, butter, or lard vary in composition accordingly. In the making of hot bread with baking powder, lard or butter is commonly used to a very large extent as "shortening." These fatty bodies render the gluten less tenacious, and the roll is thus easily broken and is without toughness or elasticity. Owing to this irregular use of shortening and of mineral matter, including salt, the composition of rolls of commerce is extremely variable. In eleven samples of rolls analyzed, for instance, the content of moisture varied from 7 to 34. Evidently the sample sold as a roll which contained only 7 percent of moisture was in point of fact a biscuit and not a roll. The percentage of ether extract in these samples varied from .43 to 7.55. The average composition of the eleven samples is as follows:

Moisture,	27.98	percent
Protein,	7.48	"
Ether extract,	3.41	"
Crude fiber,	.60	"
Ash,	1.31	"
Salt,	.69	"
Starch and sugar,	59.82	"

In the dry substance:

Protein,	10.46	percent
Ether extract,	4.74	"
Crude fiber,	.77	"
Ash,	1.81	"
Salt,	.81	"
Starch and sugar,	82.99	"
Calories,	4,538	

CAKES.

Wheat flour is one of the principal constituents of that class of sweetened bread known generally as cake. The kind and character of cake vary so greatly that no general statement of any very great value can be made respecting the average composition. In addition to the sugar and flour which are used in the manufacture of cake various flavoring ingredients or essences are employed, and usually excessive quantities of butter or lard for shortening purposes. In addition to this, other forms of cake are cooked in oil after the dough is made, thus adding an additional quantity of fatty matter to the material. Eggs are also a common constituent of cakes and these introduce into their composition additional quantities of protein and fat. Baking powder is very generally used in this country instead of yeast for the leavening of the cake and thus an additional quantity of mineral matter is introduced into their composition.

In the manufacture of sweetened cakes the flour is mixed with eggs and sugar and butter or lard to the proper consistency with or without the use of milk or cream. The cakes are baked in all kinds of sizes and shapes and may be eaten plain or in layers separated by a jelly, marmalade, or some other preserve. The exterior of the cake is often frosted with a mixture consisting of the white of egg beaten up with white sugar. The methods of mixing the ingredients of these cakes as well as the method of frosting are so various that it would not be possible to undertake any minute description of them.

For flavoring various materials are employed, either the real article or the imitation thereof, such as artificial strawberry, vanilla, etc. The cake or sweet cake is a very common dainty which is served at dessert. The ordinary cane sugar of commerce is the common sweetening matter usually employed in the refined state although sometimes yellow sugar is used. Honey is not so commonly used as a sweetening agent in this country as it is in European countries.

In the manufacture of one of the common varieties known as ginger cake sugar-cane sirup or molasses is a common ingredient.

An examination of a large number of samples of cake shows the following average composition:

Moisture,	11.65	percent
Protein,	6.29	"
Ether extract,	9.81	"
Crude fiber,	0.50	"
Ash,	1.17	"
Salt,	0.39	"
Sugar,	24.57	"
Starch,	46.01	"

In the dry substance:

Protein,	7.29	percent
Ether extract,	11.41	"
Crude fiber,	0.57	"
Ash,	1.30	"
Salt,	0.44	"
Sugar,	27.84	"
Starch,	51.59	"
Calories,	4,805	

A study of the individual data shows extremely wide variations from the mean. The ether extract in the moisture samples in some cases amounted to over 19 percent and in the dry substance to over 24 percent. The moisture in one case was over 64 percent while in the dry cake of biscuit character it sinks below 5 percent and in one case below 4 percent. The average data, therefore, are to be considered only as a representative of this class of bodies and not as a type of any particular variety.

Adulterations.—It is difficult to speak of adulterations of a substance of the composition of cake. Any wholesome flavoring or sweetening ingredient or other wholesome ingredient may be used in the manufacture of a cake of this kind without being an adulterant. From this class of bodies, however, there are excluded artificial colors and artificial flavoring essences bearing the name of genuine. A yellow cake which does not owe its color to the eggs or other normal ingredients employed must be regarded as an adulterated article, especially if the dye used in producing the yellow is one of the coal tar dyes, whether one of the anilins or a nitrated product. The use of imitation fruit flavors such as the so-called strawberry, blackberry, raspberry, vanilla, etc., is also to be regarded as an adulteration. The adulteration of cakes may be regarded as confined particularly to these two classes of articles, assuming that all the other ingredients are wholesome and without injurious effects upon the digestion. The eggs used in cake making should be fresh and palatable. Too often stale storage eggs and eggs broken or preserved with borax or formaldehyde and unfit for consumption have been used by the bakers of cakes.

Mineral coloring matters have sometimes been found in cakes and these are more objectionable by far than the artificial colors above mentioned. Where molasses from sugar-cane factories is used in the manufacture of cake a considerable trace of chlorid of tin or of zinc salts may be found therein, derived from the wash used in the centrifugal when drying sugar crystals or from the process of bleaching the molasses. This must be regarded as a very serious adulteration and molasses of this kind should never be used in the manufacture of cake nor for edible purposes upon the table. Sulfurous acid may also be absorbed during the process of bleaching the sugar-cane juices.

It is needless to add that cake with its complex character should be eaten as a relish rather than a diet. There is no hygienic or dietetic objection to the mixture of sugar with the flour in the making of ordinary sweetened bread. Such bread must be regarded as highly nutritious and as differing from ordinary bread only in a disturbance of the natural food content of the loaf caused by the addition of a carbohydrate to the bread. Many of the cakes which are sold contain so small a quantity of sugar that they ought not to be classed with the sweet cake. Out of the whole number of samples used in the making up of the above average only four contained so little sugar as to be ineligible to bear the name of sweet cake or sweetened bread.

Breakfast Foods.—A very large variety of cereal preparations are on the market under the general name of breakfast foods. These preparations are made directly from the cereals more or less completely ground by subjecting them to certain manipulations of a fermentative or culinary character by means of which the preparations are made ready for immediate consumption or at least with only a moderate degree of additional cooking. The changes which take place in the preparation of cereals for breakfast foods are of two general characters, namely, those produced by fermentative action with malt, yeast, or other ferments, and, second, changes produced by heating, either in the moist or dry state. Often both sets of changes are produced in the same product. The general difference, therefore, between a so-called breakfast food and the raw material from which it is made is found in the conversion of more or less starch into sugar and the change in the composition of the material produced by moist heat or dry heat. In the latter case the temperature may be raised so as to cause considerable caramelization.

Breakfast foods may also contain added condimental substances, such as salt, sugar, etc., sometimes used in their preparation. Nearly all the cereals or mixtures of cereals are represented in these prepared foods. Oats probably occupy the first rank and the preparations of oatmeal have to a large extent in the United States taken the place of home-prepared oatmeal for the breakfast table. Wheat, barley, and Indian corn are not far behind oats in their contributions to the numerous varieties of breakfast foods.

The particular methods of preparation are usually trade secrets and at any rate the description of the extensive technical processes would be improper in this manual. The secrets, however, are merely methods of manipulation, since it is certain that the changes of a chemical nature which take place are of the general character or class described above.

Breakfast foods are usually sold under trade-mark names which may or may not give an indication of their origin or character. Sometimes, in fact, the trade name gives a false indication and the use of such trade names must be considered as entirely reprehensible. Whenever a name used is descriptive it should be used in a practical sense and not for the purpose of misleading or deceiving. Breakfast foods may represent practically the whole grain or the grain with a removal of a proportion of the outer covering or they may represent the refined flour from which all or a considerable proportion of the germ and some of the rich nitrogenous ingredients have been removed.

The attempt to give a list of the names which have been applied to breakfast foods would consume many pages and be of little value.

Composition of Breakfast Foods.—In so far as possible the breakfast foods noted in the following tables have been arranged in accordance with the raw material from which they have been produced and the data given represent the average composition of breakfast foods of the classes mentioned. Individual variations from the average are often very great.

Class I.—Breakfast foods made from Indian corn products.
Class II.—Breakfast foods made from wheat products.
Class III.—Breakfast foods made from oat products.
Class IV.—Breakfast foods made from starch and tapioca.
Class V.—Breakfast foods made from noodles, spaghetti, and macaroni.
Class VI.—Breakfast foods made from barley.
Class VII.—Breakfast foods of miscellaneous origin, that is consisting of those compounds of raw material not specified.

COMPOSITION OF BREAKFAST FOODS.*

	Moisture.	Proteids.	Ether Extract.	Fiber.	Ash.	Starch and Sugar.	Calories. Per Gram.
Class I, *Indian Corn Products:*							
	Perct.	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	
In the original substance, .	12.33	7.92	0.58	0.67	0.66	78.51	. . .
In the dry substance, . .	. .	9.02	0.66	0.76	0.75	98.57	4385
Class II, *Wheat Products:*							
In the original substance, .	10.08	12.01	1.80	1.48	1.55	75.62	. . .
In the dry substance, . . .	. .	13.36	2.01	1.65	16.73	84.08	4462
Class III, *Oat Products:*							
In the original substance, .	7.66	15.32	7.46	1.20	1.79	67.61	. . .
In the dry substance, . . .	. .	16.60	8.08	1.38	1.94	73.20	4875
Class IV, *Starch and Tapioca Products:*							
In the original substance, .	11.29	.39	.03	.13	.14	88.15	. . .
In the dry substance, . . .	. .	.43	.04	.15	.16	99.37	4193
Class V, *Noodles, Spaghetti and Macaroni:*							
In the original substance, .	9.66	12.02	.42	.56	.78	77.12	. . .
In the dry substance, . . .	. .	13.33	.47	.62	.86	85.34	4428
Class VI, *Barley Products:*							
In the original substance, .	10.92	7.50	.89	.67	.86	80.35	. .
In the dry substance, . . .	. .	8.42	1.00	.75	.97	90.19	4344
Class VII, *Miscellaneous Products:*							
In the original substance, .	6.41	12.81	1.05	.99	1.06	78.68	. . .
In the dry substance, . . .	. .	13.68	1.12	1.04	1.13	84.07	4449

Remarks on Table of Analyses.—

Class I, Indian Corn Products.—The analytical data show that in the breakfast foods made from Indian corn products the germ has been quite uniformly removed. The quantity of fiber also shows that the maize flour produced has been very carefully bolted. The ash is almost normal, showing only a small addition, probably of salt. The mean quantity of protein is that which would be predicted of an Indian corn product ground by the most approved milling process in order to make as white a flour as possible. These methods of preparing the flour, although so common, are not to be preferred either by reason of palatability or nutritive properties of the products. The old-fashioned milling process makes a more palatable and more nutritious diet and affords a higher degree of heat and energy.

The analysis of the Indian corn products show that they are very much lower in protein than would be expected from an analysis of the whole kernels. The low content of fat in the products is doubtless due to the complete degermination of the grain during the milling and to the further fact that the baking and other preparation of the material tend to occlude the fat particles, making their extraction quite difficult.

Class II, Wheat Products.—The study of wheat products used as breakfast foods shows that the wheat germ is not removed to any very great extent during the preparation of the raw material. In fact the quantity of ether extract appears somewhat greater than would be expected in pure wheat

*U. S. Dept. Agr., Bureau of Chemistry, Bull. 13, Part IX, p. 1345.

products, and this leads to the supposition that oatmeal or Indian corn must be mixed with the food product in small quantities, since the ether extract in the case of wheat products is more than three times as great as in the case of Indian corn products of a similar character. This is an indication either of the use of mechanical methods as stated above or else of the admixture of other bodies without mention. There does not appear to have been any notable quantity of mineral substance, common salt or otherwise, added during the process of preparation. The quantity of protein in the product is that which would be predicted from the composition of wheat flour from which the samples are supposed to be made.

Class III, Oat Products.—The oat products have evidently been made without any extensive degermination, as is shown by the high content of fat or oil. The average composition of oat products shows that genuine oatmeal is used in their preparation and the probability is that little adulteration is practiced. The high content of oil and protein produces a corresponding depression in the quantity of carbohydrates. The high nutritive value of the product, both in respect of fat and of proteins, is fully illustrated by the analytical data obtained. The calories, as will be noticed, are very much higher than in the corresponding product from Indian corn, wheat, or in fact of any other of the breakfast foods.

Class IV, Products made of starch and tapioca show, in the analytical data, that very high-grade starch materials are employed in the preparation of these bodies. The protein, ether extract, fiber, and ash almost disappear. As shown in the data for the dry substance, more than 99 percent of the whole material consists of carbohydrates, chiefly starch. The calories are correspondingly diminished since starch and sugar have the least heat value of any class of food products, except those of a mineral character. Foods of this kind are highly unbalanced, that is, contain a large excess of starch and sugar, and are often very prejudicial to the health of persons whose ability to digest starch and sugar has been lessened by disease.

Class V, Noodles, spaghetti, and macaroni are often used as breakfast foods, though not by any means so universally as many others in this category. The analytical data show that these bodies correspond very well to the material, that is to the flour, rich in gluten, from which they are supposed to be made. The protein content is high,—the ether extract, fiber, and ash low, and the calories correspond to the chemical composition of the material.

Class VI, Barley Products.—Barley products are not very commonly used as breakfast foods, but the malt used in the preparation of other breakfast foods is usually made of barley, since the barley malt has the highest diastatic value of any of the cereals.

Class VII, Miscellaneous breakfast foods are so called because the character of the materials of which they are made is not known or no statement is made by the manufacturer or dealer concerning them. The analytical data, of course, do not lead to any decision regarding the nature of the raw material employed. The percentage of protein, however, taken in conjunction with the rather low ether extract, indicates that they are probably made chiefly from wheat products.

Much may be said in favor of the use of prepared breakfast foods, for, in so far as I know, they are usually palatable, wholesome, and nutritious. There are many points which may be urged against their general use, chief of which is in regard to their cost. There is no cereal now in general use for edible purposes which is worth as much as two cents per pound in the markets of this country, yet breakfast foods, which are only prepared cereals, are often sold for 10 or 15 cents per pound. This is a high price in comparison with the cost of the raw material, but it must not be forgotten that the cost of manufacture is to be considered. In the second place the cereal foods are undoubtedly best at the moment they are prepared. Unless carefully packed, they may become infected with insects of various kinds, which certainly add nothing to their value and detract very much from their desirability. In moist climates they become infested with mould and even with bacterial growths. Inasmuch as necessarily a large proportion of the prepared cereals remain for an indefinite time unsold, the consumer is liable at any time to come into possession of one of these deteriorated packages. In the third place there is no reason to believe that a prepared breakfast food is any more digestible, nutritious, or favorable to the health of the healthy individual than the broken cereal itself properly cooked. Further than this it may be stated that there is no preparation of cereals better than those which are freshly made from the freshly broken or ground grain. If, therefore, one has the time to properly prepare the fresh grains of the cereals they will be more palatable and more nutritious and equally as digestible as any of the prepared articles. On the other hand, there are cases of diseased or disordered digestion in which the prepared cereals will be more digestible, but this is certainly not the case in a state of health. There is reason to believe, therefore, that the demand for prepared cereals will continue, but the old-fashioned method of preparation of the cereal from the grain will still have its advocates.

I think it may be said with certainty that the proper home preparation of a cereal as a breakfast food will not cost any more than the original cereal itself, and hence the price of this food ought not to be much more than 4 cents per pound without counting the added water in its preparation.

I believe, therefore, that our people of limited means can be safely advised on the score of economy, palatability, and nutrition to prepare their own cereals for ordinary breakfast purposes.

Economy in Nutrition.—In the present era of high cost of living the question of economy in the food supply is one which is receiving general attention. There is no economy, however, in debasing the quality of food or diminishing its quantity below the amount required to restore wasted tissue, provide for growth and furnish the margin of safety which every well regulated organism provides. If the food supply be debased by any sort of manipulation whereby its nutritive properties are impaired, the damage done the body is more costly than the money saved in the purchase of the food. If the supply of food is diminished below the amount specified above, the organism has no reserve power, and easily falls a prey to infection and disease, the loss in efficiency and the cost of medication far outweighing any diminution in the cost of purchasing the foods. Nevertheless there are many matters concerning the character of the foods already described which are worth considering in this connection. Pound for pound the cereals are the cheapest complete food on the market. Wheat at a dollar a bushel costs 1.33 cents a pound. Eighty percent of wheat is fit for human food, and, in fact, the whole wheat properly crushed is believed by many experts to be the best complete food with the possible exception of milk. Wheat contains only 12 percent of water while milk contains 87 percent. Milk with 13 percent of solids costs 5 cents a pound, and wheat which contains 88 percent of solids costs 1.33 cents a pound. Ten cents expended for milk buys 0.27 pound of nourishment while ten cents expended for wheat buys 8.8 pounds.

A pound of average meat costs 18 cents and is not much over 45 percent food. It contains nearly half its weight of water and also much bone and cartilage. Ten cents spent for meat buys 0.56 pound, of which less than half is food, or, in other words, less than a quarter of a pound of food. Moreover, this meat is not a complete food, lacking the carbohydrate element. Milk at ten cents a quart and meat at 18 cents a pound afford the same amount of food, but the milk ration is a complete food and the meat ration is not.

In this computation the cost of milling the wheat and baking the bread and meat has not been included. In the exercise of true economy the wheat should be taken to the mill and the entire yield of the mill less the toll, viz., $\frac{1}{8}$ of the whole, be returned to the consumer. Where economy is to be considered the preparation and baking of the product should be done at home. In such an economical household, the food will be chiefly cereals in the form of bread or other appetizing preparations, with milk only for the children, and meat, vegetables and fruits in moderation. Many a laboring man would find the burden of life greatly lessened by heeding these facts.

The burden of life is heavy enough for the laborer who earns scarcely three hundred dollars a year, and he should be taught how he can best feed his family on this sum and save enough for rent, clothing, and schools. A diet of plain, unprepared cereals will do more for the poor than politics, grammar or geography.

PART VI.

VEGETABLES, CONDIMENTS, FRUITS.

SUCCULENT VEGETABLES.

The term vegetable as applied to food in the broadest sense of the word means that class which distinguishes it from animal food. In a narrower sense, however, the term vegetable is used to denote a certain form of food which is of a succulent or juicy nature. While cereals and fruits are vegetables in the broadest sense of the word they are not in the narrow and common meaning. The term "vegetable" in this section therefore refers to those substances commonly known as vegetables upon the market and which are characterized by their high water content. On account of this abundance of liquid or juice the term succulent is applied to them. The common vegetables which are included in this class consist of lettuce, spinach, potatoes, cauliflower, beets, radishes, turnips, cabbage, green Indian corn, peas, beans, tomatoes, yams, etc. These vegetables contain in a fresh state from 70 to 95 percent of water. Many of them can be kept for a length of time without deterioration, especially the potato and beet, and for a short time cabbage, radishes, etc., if kept cool and moist. Other kinds of vegetables are not easily preserved for any length of time except in cold storage, such as lettuce, peas, beans, tomatoes, etc. If the potato and other starchy tubers are kept out of account these vegetables do not have a very high nutritive value, as will be seen by the analyses which follow. They have, however, an important part in the ration because of their palatability and the effect which they have upon the general activity of the alimentary canal. For instance, there is very little nourishment obtained in eating a turnip which perhaps is 95 percent water,—yet its palatability, its condimental character, and its general salutary effect upon digestion is such as to make it worth while to pay even a high price in proportion to its nutriment. For this reason, as well as for their nutritive value, the use of succulent vegetables is to be very highly commended.

In general, as has been said, these vegetables are eaten in a fresh state or after being kept for a considerable time in cold storage or otherwise. The potato, for instance, can be kept by properly covering it in the earth or in bins through the winter. Cabbages are also kept in the same way and many other vegetables without apparent deterioration. These vegetables are often desiccated, and in this way can be kept for a much longer period. Unfortunately no method of desiccation has been developed which preserves entirely the palatability of the vegetable, although its nutrient properties, which are perhaps the least important of its properties in many respects, are preserved to a certain extent by desiccation.

We may, however, leave out of consideration the desiccation of fresh vegetables. Certain of the vegetables above mentioned naturally become desiccated on maturity as in the case of peas and beans, but then they are removed from the category of succulent vegetables. Green Indian corn is also often dried, but in this process its palatability is to a certain extent impaired even when it is prepared for cooking in such a way as to restore practically all of the water which has been lost. Succulent vegetables are eaten either in a raw state or after cooking. For instance radishes and vegetables of this class are rarely cooked. On the other hand, potatoes, peas, and beans are always cooked and practically never eaten raw. Green Indian corn is also universally cooked before eating. There are other vegetables which are sometimes eaten raw and sometimes cooked, as, for instance, the turnip, while on the other hand the beet, which is very sweet and naturally would be considered a suitable food for eating in a raw state, is always cooked before it is consumed.

Artichoke (*Cynara scolymus*).—This vegetable, while not very generally grown in the United States, is cultivated to a very extensive degree in Europe. The flower heads and the fleshy base on which they grow are the edible portions.

The Jerusalem artichoke (*Helianthus tuberosus* L.) is a plant of the aster family which has edible tubers that form a valuable carbohydrate food. The carbohydrates which are present in this artichoke do not contain very much starch. In this respect they differ from the potato and the yam. When the starch of the potato and yam is converted by fermentation or otherwise into sugar it forms chiefly dextrose or maltose. On the other hand, when the carbohydrates of the artichoke are converted into sugar they form chiefly levulose. The principal part of the carbohydrate is known as inulin or levulan. The artichoke can be easily kept over a long period of time, and may remain without much detriment in the ground, where the winters are not severe, from autumn until spring. After harvesting it may be kept for some time without any very great loss in its food value.

In the following table are given the data showing the composition of the Jerusalem artichoke, harvested in the autumn:

Fall:

Water,	79.70	percent
Inulin or levulin,	16.93	"
Protein,	1.48	"
Ether extract,	.14	"
Ash,	1.08	"

(Behrend, J. für Landwirtshaft, vol. 52, p. 134, 1904.)

The above data show that the artichoke, like the potato, is a food product poor in protein and in fat and rich in carbohydrate material. In so far as known the carbohydrates of artichokes are equally as digestible and nutritious as those of other tubers.

Asparagus.—Asparagus (*Asparagus officinalis* L.)—French, asperge; German, spargel; Italian, sparagio; Spanish, esparrago—is a highly prized vegetable and is a native of Europe. The edible asparagus is the young, fresh, undeveloped shoots taken at an early period of growth. They are highly valued when stewed or for use as a salad. There is a number of varieties of asparagus, among which may be mentioned the Giant Dutch asparagus, the common green asparagus, white German asparagus, etc. These are different in kind only, since they all belong to the same botanical species and the variations are produced chiefly by different methods of cultivation.

Composition.—

Water,	93.96	percent
Ash,	.67	"
Protein,	1.83	"
Fiber,	.74	"
Sugar, starch, etc.,	2.55	"
Fat,	.25	"

Asparagus is composed chiefly of water, which amounts, in round numbers, to 94 percent of its entire weight. Its edible portion is rich in protein as compared with the beet and many other vegetables. It is somewhat richer also in fat than the beet or the turnip. Its food value, as will be seen, is largely of a condimental character.

The Bean.—The bean belongs to the family Fabaceæ. It is a native of America and has been cultivated from the earliest times. There are many different varieties of the bean which are cultivated in this country. They grow over the whole range of the United States. There are early and late maturing varieties. Beans are used for food both in the fresh state, while the pods are tender and can be eaten with the immature beans, and also in the dry state, in which condition they are a staple article of food. There are many different varieties of beans which, while not always botanically identical, are sufficiently so to warrant the use of the common name. Two general classes, however, may be distinguished, namely, those that grow in small clusters or bunches and those that grow upon vines or tendrils which have to be supported. In regard to the kinds of culture to which beans are subjected there may be mentioned field beans, which are cultivated over a large area, and garden beans, which are cultivated in small gardens for the green markets.

Kidney Bean.—The kidney bean, or French bean, is a special botanical variety (*Phaseolus vulgaris* L.). It is what is known in French as haricot; in German as Bohne; Dutch, Boon; Italian, faginolo; Spanish, habichuela. This variety of bean is commonly called a French bean and is a native of South America. It does not seem to have been known before the discovery of the American continent and hence is not thought to have grown wild in any other part of the world. The kidney bean is not very well suited to very high northern latitudes, since it is particularly sensitive to the cold, even if the temperature is not low enough to produce frost. The kidney bean is cultivated over large areas and is also a garden crop. There are early and late varieties, so that the season for the kidney bean is a long one. The pods of this bean are distinguished by being long and slender, and it is particularly valuable for edible purposes while green and is also prized for canning. This is true, especially, of that variety which has a tender pod.

There is another variety of bean in which the pod is tough, and this, of course, is not so well suited for eating green, although when very young, even the tough-podded bean can be used. There are a great many different varieties of kidney beans known, one of which is called the "dwarf kidney bean" on account of its growing only on low bushes and needing no support for the vines. In this variety the pods hang in thick clusters, the lower ends often touching the ground.

Butter Beans.—There is another large class of beans known as butter beans. This variety is also known as Geneva, or plainpalais, or wax bean.

Lima Beans.—The Lima bean is also a different botanical species known as *Phaseolus lunatus* L. It is nearly related to the kidney bean, being also a native of South America. The vine is a very long one, often reaching more than 10 feet if a proper support be offered it. The common Lima bean is one which matures rather late in the season, but it is most highly valued for its product, which is eaten shelled. There are smaller varieties of this bean known as the dwarf Lima or small Lima.

The total number of varieties of beans which are known and cultivated is, perhaps, more than 100, but they belong in general to the large classes specified.

Average Composition of Green, String, and Lima Beans.—

Lima beans:

Water,	68.46	percent
Ash,	1.69	"
Protein,	7.15	"
Crude fiber,	1.71	"
Carbohydrates,	20.30	"
Fat,	.69	"

String beans:

Water	87.23 percent
Ash	.76 "
Protein	2.20 "
Crude fiber	1.92 "
Carbohydrates	7.52 "
Fat	.37 "

The above data are for green *Lima* beans with the pod removed and for *string* beans including the pod. The latter, it is seen, are composed largely of water, containing less than 13 percent of dry matter. Of the dry matter almost 20 percent is protein. The soluble carbohydrates, including the starch and sugar, are the most important of the ingredients of the dry substance in so far as actual weight is concerned. In the Lima bean the protein is more than three times as great as in the string bean, and the starch and sugar almost three times as much. As a nutrient, therefore, the Lima beans are far more valuable than the string beans. These data may be taken as representative of all varieties of green beans, hulled and unhulled, the Lima beans being types of hulled beans and the string variety being the type of beans including the pod.

Composition of the Dry Bean.—

Water	15.86 percent.
Ash	3.53 "
Protein	20.57 "
Fiber	3.86 "
Sugar, starch, etc.	55.49 "
Fat	.69 "

The analyses show that the dry bean is much richer in protein than the cereals.

Beets.—All the varieties of edible beets belong to the common species *Beta vulgaris* L. French, betterave; German, Salat-Rübe; Dutch, Betwortel; Italian, barbabietola; Spanish, remolacha.

The most important of these beets, economically, is the variety which has been cultivated for the purpose of producing sugar. By long years of selection and improvement the sugar content of the natural beet, which is not more than from four to six percent, has been brought up to an average of about 14 percent, often reaching much larger quantities. The sugar beet itself, in its earlier stages, makes an excellent vegetable for the table, being particularly sweet and palatable. Its tannin content, however, is very high, and before cooking, especially, it has quite a bitter taste, at times. This disappears in the young beets when they are cooked. The sugar beet has a perfectly white flesh, inasmuch as the attempt was made in the early period of cultivation to develop a beet without color in order to produce a white sugar with as little trouble as possible. On the other hand the garden beet is usually highly colored, the red beet being especially prized. The number of varieties of beets in cultivation is very great. Among the most important may be mentioned the long blood-red beet, which is the common garden beet, the rough-skinned red beet, the pear-shaped beet, the turnip-shaped beet, all of which are of the red color. There is also cultivated for eating purposes a beet with yellow flesh, though it is not by any means so common as the red garden beet.

Composition of the Beet.—The following data represents the average composition of the red beet used as a vegetable:

Water,	88.47	percent
Ash,	1.04	"
Protein,	1.53	"
Fiber,	.88	"
Sugar, starch, etc.,	7.94	"
Fat,	.14	"

The above data show that the average garden beet has a little less than 12 percent of solid matter and a little more than 88 percent of water. It is rather poor in protein, though it is not a vegetable which can be classed as being excessively deficient in nitrogenous constituents. Its chief food value, however, is in the sugar which it contains, which is more than 7 percent. It is quite deficient in fat.

Brussels Sprouts.—Brussels sprouts is a variety of cabbage which is grown over large areas in different countries and has a deservedly high reputation on the table. The French name is chou de Bruxelles; German, Brüsseler Sprossen-Kohl; Italian, cavolo a germoglio; Spanish, bretones de Bruselas. The composition of Brussels sprouts is practically the same as that of cabbage.

Cabbage.—The botanical name of the cabbage is *Brassica oleracea* L. and it belongs to the family Brassicaceæ. It is a plant which is indigenous to both Europe and Asia, and still grows wild in some parts of the European continent. It is eaten both raw, in the form of salad, slaw, etc., and cooked in various methods. It is also subjected to a fermentation, producing the highly prized dish known as sauer-kraut. Its French name is chou cabus; German, Kopfkohl; Italian, cavolo cappuccio; Spanish, col repollo.

The cabbage is a plant which, as it approaches maturity, has its leaves folded upon each other in a solid mass, producing the head. These leaves naturally become bleached and are extremely crisp and tender. The external, free leaves are not prized as a food. The varieties of the cabbage are almost legion and are produced by different methods of cultivation.

Composition.—

Water,	90.52	percent
Ash,	1.40	"
Protein,	2.39	"
Fiber,	1.47	"
Starch, sugar, etc.,	3.85	"
Fat,	.37	"

The above data show that cabbage is composed chiefly of water, amounting to as much as 91 percent of its weight. Its principal food constituents are starch, sugar, and digestible fiber. Its most valuable food constituent is most probably the protein, of which it contains a large proportionate quantity. In all its forms cabbage is a wholesome, if not very nutritious, dish.

Carrot.—The botanical name of the carrot is *Daucus carota* L. French, carotte; German, Mohre; Italian, carota; Spanish, zanahoria.

This plant is indigenous to Europe. The carrot is naturally a biennial plant, though it is often produced in a single season, and especial efforts are made to produce quick-growing carrots. This vegetable is much more common in Europe than in the United States, and when grown here at all it is used chiefly in soups and often for cattle food. There is a large number of varieties of carrots, but practically all belong to the same botanical species. The flesh is often of a yellow tint, though blood-red carrots are grown and highly prized.

Composition.—

Water,	88.59	percent
Ash,	1.02	"
Protein,	1.14	"
Fiber,	1.27	"
Starch, sugar, etc.,	7.56	"
Fat,	.42	"

It is seen from the above data that the carrot has almost exactly the composition of the garden beet. Its principal food value is in the sugar and other carbohydrates which it contains. It also has a notable proportion of protein and has almost 12 percent of solid matter.

Cauliflower.—Cauliflower is a variety of cabbage the edible portion of which is the extraordinarily modified and thickened flower cluster. It is more tender and delicate in its structure than the common cabbage. The French name is choufleur; German, Blumenkohl; Italian, cavolfiore; Spanish, coliflor.

It is highly prized when prepared for the table with a sauce. It is a dish which is much more common in Europe than in this country, where it is not appreciated as it should be. There is a large number of varieties produced, chiefly by the different methods of cultivation and the effect of environment in which they are grown.

Composition.—

Water,	90.82	percent
Ash,	.81	"
Protein,	1.62	"
Fiber,	1.02	"
Sugar, starch, etc.,	4.94	"
Fat,	.79	"

The cauliflower is very close to the cabbage in composition, having, however, a slightly larger proportion of digestible carbohydrates and a much larger proportion of fat. Its dietetic value, however, is not notably different from that of the cabbage.

Celery.—One of the most important vegetables upon the table in this country is celery. The botanical name of celery is *Apium graveolens* L. The French name is celeri; German, Sellerie; Italian, sedano; Spanish, apio.

Celery is indigenous to Europe. It is eaten in its young state, and is most valued when the stalks are bleached. This is accomplished by hilling up the earth around them or protecting them from the light by boards or otherwise. Kept in the dark in this way the green color fades and the stalks become more crisp and brittle. There are several kinds of celery grown, but these are chiefly due to the different methods of cultivation. Celery is not only eaten raw but also stewed and is a common constituent of soup. Celery seeds are supposed to have not only a condimental but a medicinal value.

Chicory.—The botanical name of chicory is *Cichorium intybus* L. In French it is called chicorée sauvage; German, wilde or bittere Chichorie; Italian, cicoria selvatica; Spanish, achicoria amarga o agreste.

The wild chicory is used chiefly, even in its cultivated state, for salad purposes, the roots not being of any value on account of their smallness. The chicory, however, develops under cultivation a large root like the carrot or turnip, and this variety of chicory is used chiefly on account of the roots, which, when they are roasted properly, are highly prized as a substitute for coffee. The common wild chicory has been used from time immemorial as a salad. The leaves have rather a bitter taste and are more highly prized for salad purposes when mixed with lettuce or other leaves which have a less pronounced flavor. The variety of chicory of which the roots are used as a substitute for coffee is known as "Brunswick chicory," or Magdeburg large-rooted chicory.

Composition of the Root.—

Water,	79.20	percent
Ash,	1.11	"
Sugars,	.60	"
Inulin,	14.00	"
Fiber,	1.29	"
Protein and undetermined,	3.50	"

Starch does not appear to be among the carbohydrates in chicory but inulin takes its place. In this respect chicory resembles the artichoke in its composition.

Roasted Chicory.—When chicory is used as a substitute for coffee or as a substance added to coffee it is roasted, and its composition is thus materially changed, as is represented by the following data:

Moisture,	13.3 percent
Ash,	5.9 "
Sugar,	12.4 "
Inulin,	4.3 "
Fiber,	6.9 "
Caramel and undetermined,	57.2 "

From the data of the above analysis the inulin does not appear to have been very largely converted into levulose by roasting, but rather into the insoluble carbohydrate matter. Whether or not, therefore, the inulin exists in the large proportion given in the analysis of the fresh chicory is a matter of some doubt.

Cranberry.—The cranberry is grown extensively in the swampy grounds of the northern part of the United States, especially in New England, New Jersey, and Wisconsin. It is a red, hard berry, not at all pleasant to the taste in its fresh state, very acid, but greatly valued during the autumn and winter months when stewed with sugar and served as a sauce, especially with turkey. Its chief use, in fact, is to eat with turkey or chicken. The cranberry is a fruit which contains naturally a small quantity of benzoic acid.

Composition.—

Water,	86.10 percent
Solids,	13.90 "
Soluble solids,	8.43 "
Acidity,	1.98 "

(Measured as grams of sulfuric acid per 100 grams of material.)

Cress.—The botanical name of cress is *Lepidium sativum* L. French, cresson alenois; German, Garten-Kresse; Italian, agretto; Spanish, mastuerzo.

It is a plant which is indigenous to Persia. It grows in this country in moist gardens and particularly in the warmer parts of the country. The real water cress belongs to a different species, its botanical name being *Rorifa nasturtium*. It grows only in water, in which it differs from the preceding variety. It is highly prized as an aromatic flavoring material and for table use. There are very many varieties in cultivation.

Cucumbers.—The botanical name of cucumber is *Cucumis sativus* L. French, concombre; German, Gurke; Italian, cetriulo; Spanish, cohombro.

The cucumber is indigenous to East India, but is now cultivated in all countries. It is a plant which develops vines which often run to great distances. The cucumber is used almost exclusively in its green state, and the very young cucumbers are most highly prized for making pickles, though all sizes are used for that purpose, from the very smallest to the giant variety. The number of varieties cultivated is extremely great. The variety known as the gherkin is highly prized for pickling.

Composition of the Cucumber.—

Water,	95.99	percent
Ash,	.46	"
Protein,	.81	"
Fiber,	.69	"
Starch, sugar, etc.,	1.83	"
Fat,	.22	"

The above data show that the cucumber is not much more than solid water, there being just enough of other material to give it a flavor and consistence.

Egg Plant.—Another vegetable which is highly prized for the table is the egg plant, *Solanum melongena* L. French, aubergine; German, Eierpflanze; Italian, petronciano; Spanish, berengena.

The egg plant is indigenous to India. Its name is derived from the shape of some of its varieties, though many of them have ceased to resemble the egg in appearance. There is a large number of varieties, but the one which is known as the white egg plant looks more like an egg both in shape and color than most of the others.

Composition.—

Water,	92.93	percent
Ash,	.50	"
Protein,	1.15	"
Fiber,	.77	"
Starch, sugar, etc.,	4.34	"
Fat,	.31	"

The egg plant is a highly succulent vegetable containing only a little more than 7 percent of solid matter, and this is chiefly sugar, starch, and other digestible carbohydrates.

Garlic.—The botanical name of garlic is *Allium sativum* L. French, ail ordinaire; German, Gewöhnlicher Knoblauch; Italian, aglio; Spanish, ajo vulgar.

This highly prized aromatic vegetable is indigenous to southern Europe. It is a perennial plant, and the edible bulbous portion grows chiefly underground. This part is used for spicing food. It is eaten in large quantities by the Latin nations of southern Europe, and is employed throughout the world as a seasoning or flavoring for many dishes. When eaten in excess it makes the breath extremely disagreeable, as can be witnessed by all who have traveled in the Latin countries of Europe and even among the South Germans. Garlic is not eaten to any extent by our native citizens, but is used by our first-class cooks extensively as a seasoning. A little of it is known to go a great way. Its composition is very much like that of the onion. A wild garlic grows in the United States over wide areas. It is often eaten by cows, and it imparts to the milk a very disagreeable flavor and smell.

Gourds.—Gourds themselves are not very much used for edible purposes, but the varieties which include all the species of pumpkin and squash belong to the important vegetable foods in the United States. The most important member of this family is the pumpkin, *Cucurbita pepo* L., which grows often to an enormous size and has a beautiful yellow color. The French name for the pumpkin is potiron; German, Kurbiss; Italian, zucca; Spanish, calabaza totanera.

The pumpkin of California, especially, is noted for its gigantic proportions. The pumpkin is used very extensively in New England, as well as other parts of the country, for making pies, and is also used as a sauce. The pumpkin is not eaten raw. As a cattle food it is highly prized in all parts of the country, and when fed to milch cows it imparts to the butter, even in the winter, a delicate amber tint.

Composition of the Flesh of the Pumpkin.—

Water,	93.39	percent
Ash,	.67	"
Protein,	.91	"
Fiber,	.98	"
Sugar, starch, etc.,	3.93	"
Fat,	.12	"

It is seen that the flesh of the pumpkin is essentially a watery food, the chief ingredient of the solid matter being sugar. Its value, therefore, as a food is more condimental than nutritive.

Horse-radish.—The botanical name of horse-radish is *Cochlearia armoracia* L. French, raifort sauvage; German, Meerrettig; Italian, rafano; Spanish, taramago.

The horse-radish is prized as one of the principal condimental vegetable substances in common use in the United States. It is particularly used with oysters and other foods of similar character and as a sauce or spice in a salad. It is indigenous to Europe, but is now cultivated everywhere. There are many varieties, but they are all characterized by a sharp, pungent taste and odor.

Adulteration of Horse-radish.—Other vegetable substances, as, for instance, the more highly spiced aromatic turnips, are often substituted for horse-radish.

Horse-radish is often prepared by proper grinding mixed with vinegar and sold in sealed bottles. There is no objection to this practice provided the samples are not kept too long. When convenient, however, it is better to purchase the plant and grate it immediately before using.

Kale.—Kale is a variety of cabbage which is somewhat different botanically from the common cabbage. This form of cabbage does not make a firm head, but grows only with free leaves. It is especially adapted for use in much the same manner as the common substances known by the housewife as greens. It is a hardy plant and grows well even in cold climates. There are a great many varieties of kale, and the composition is practically that of the cabbage.

Leek.—The leek is of the same variety of plant as the garlic. Its botanical name is *Allium porrum* L. French, poireau; German, Lauch; Italian, porro; Spanish, puerro.

The leek is thought to be indigenous to Switzerland, though this is not quite certain. It is closely related to the garlic and onion and is valued for the same purposes, namely, its highly aromatic condimental character.

Lettuce.—Among the most valued of the succulent vegetables is the lettuce. Its botanical name is *Lactuca sativa* L. French, laitue cultivée; German, Lattich; Italian, lattuga; Spanish, lechuga.

Lettuce is thought to be indigenous to India or Central Asia. It has been cultivated, however, for so long that its origin is a matter of doubt. There is a legion of varieties of lettuce, but they all have essentially the same characteristics and have little food value. Lettuce is now found practically throughout the whole year in all civilized countries, being grown under glass in winter so as to furnish a continuous supply for the markets throughout the year. It is used chiefly as salad, and among the varieties which are most highly prized for this purpose are the cabbage lettuce and the variety known as Romaine. The Romaine is distinguished from the common lettuce by the shape of the leaves, which are much longer and narrower than those of ordinary lettuce. The Romaine lettuce is more highly prized by most connoisseurs as being more tender and brittle than the first variety.

Composition.—

Water,	93.68	percent
Ash,	1.61	"
Protein,	1.41	"
Fiber,	.74	"
Sugar, starch, etc.,	2.18	"
Fat,	.38	"

The data show that lettuce is a highly succulent vegetable. Its chief food constituents are protein and sugar. Its real value as a food is not shown by chemical analysis because it consists in a delicate, aromatic flavor which is not revealed by the crucible.

Melons.—There are two kinds of melons eaten in the United States,—the first the watermelon, and the second the cantaloupe or muskmelon. In Europe the principal melon which is used is one having deep yellow flesh resembling the color of a pumpkin and known as the French melon. The botanical name is *Cucumis melo* L. French, melon; German, Melone; Italian, popone; Spanish, melon.

The French melon is indigenous to Asia, but only the cultivated varieties are known now. The flesh is very sweet and is, as has already been said, usually of a deep yellow color, though there are many different varieties.

Cantaloupe.—This is a general name given to the melons of the French type or varieties thereof growing in the United States. It is supposed to have had its origin in Italy, though there is some doubt on the subject. The cantaloupe is of various sizes and shapes and various degrees of sweetness. In the United States the variety grown at Rocky Ford, Colorado, is noted for its sweetness and general palatability. For this reason many melons not grown at Rocky Ford are improperly sold under that name. There are a great many varieties of canteloupes. Generally the flesh of the cantaloupe is a greenish yellow instead of yellow. The muskmelon is quite like the cantaloupe in appearance and flavor.

ANALYSIS OF JUICE OF MUSKMELONS.

FROM RIND OF MELON.

SERIES NO.	BRIX.	NITROGEN.	ASH.	SUCROSE.	REDUCING SUGAR.
		Percent.	Percent.	Percent.	Percent.
495,	11.5	.106	1.23	3.99	3.97
554,	8.4	.018	0.66	2.47	3.62
587,	5.0	.053	0.47	2.25	2.84
613,	10.3	.156	0.93	2.77	3.64
Average,	8.8	.083	0.82	2.87	3.52

JUICE OF EDIBLE PORTION OF MELON.

SERIES NO.	BRIX.	NITROGEN.	ASH.	SUCROSE.	REDUCING SUGAR.
		Percent.	Percent.	Percent.	Percent.
495,	12.9	.130	1.20	6.60	2.88
554,	8.2	.069	0.87	4.96	2.47
587,	5.8	043	0.50	2.26	2.57
623,	11.5	.134	0.95	5.19	2.25
Average,	9.6	.094	0.88	4.75	2.54

Watermelons.—This is an entirely different variety from the French melon or cantaloupe. Its botanical name is *Citrullus citrullus* L. French, melon d'eau; German, Wasser-Melone; Italian, cocomero, Spanish, sandia.

The watermelon is said to be indigenous to Africa. It is grown extensively in the United States, especially in the southern part. It is a field crop of considerable importance, especially in the state of Georgia. The watermelon grows best on a sandy soil, though it requires it to be well fertilized. The vines, when they reach their full growth, cover the entire field. The melons often grow to a very large size,—specimens weighing from 50 to 60 pounds being not unusual. The average size, however, is much less than that. The Georgia melon is somewhat oval in shape, reaching generally from a foot to eighteen inches in length and from a foot to fifteen inches in diameter. The flesh is generally red and the seeds usually black. The watermelon is in the market from early summer until the late autumn. It bears shipping quite well, and is sent usually in box cars without crating, and, if kept at a low temperature, will remain palatable for many days or even weeks. The fresh ripe melon, however, is far superior in quality to any that are harvested partly green and kept for a long time. About forty or fifty varieties of watermelons grow in the United States.

Composition of Melons.—The following data show the composition of the flesh of the muskmelon and the watermelon:

Muskmelon:

Water,	89.50 percent
Ash,	.60 "
Protein,	.60 "
Fiber,	.92 "
Starch, sugar, etc.,	8.20 "
Fat,	.18 "

Watermelon:

Water,	91.87 percent
Ash,	.33 "
Protein,	.40 "
Fiber,	.55 "
Starch, sugar, etc.,	6.65 "
Fat,	.20 "

The above data show that the edible portion of the muskmelon contains more nutrient matter than that of the watermelon, the difference being chiefly in the content of water and carbohydrates.

Okra.—The French name for okra is gombo; Italian, ibisco; Spanish, gombo.

Okra is a vegetable grown very largely in the United States and especially valued for use in soup making. For this purpose the young seed-vessels are employed. The seed pods of the okra are long, tapering, and rigid by reason of quite sharp angles. The okra is often known as gombo or gumbo.

Composition.—

Water,	87.41 percent
Ash,	.74 "
Protein,	1.99 "
Fiber,	3.42 "
Starch, sugar, etc.,	6.04 "
Fat,	.40 "

Onion.—The botanical name of the onion is *Allium cepa* L. The French name is ognon; German, Zwiebel; Italian, cipolla; Spanish, cebolla.

The onion is a plant which is valued for edible purposes throughout the whole world. It is supposed to have been indigenous to Asia, but its exact origin is not known with certainty. Both the pulp and the part of the stem immediately attached thereto are edible. In fact in very young plants the whole plant is edible. Its highly aromatic character and flavor rather than its nutritive qualities give it its chief value. The onion is eaten both raw and in various cooked forms. Cooking the onion, especially boiling, expels a large part of its most pungent character, so that the cooked onion does not manifest itself so unpleasantly in the breath when eaten as is the case with the raw onion. The onion is also very commonly eaten in this country fried, especially with beefsteak. The variety of onions cultivated is legion, but they are due rather to different methods of cultivation, etc., than to botanical character.

Composition.—

Water,	87.55	percent
Ash,	.57	"
Protein,	1.40	"
Fiber,	.69	"
Sugar, starch, etc.,	9.53	"
Fat,	.26	"

The onion, it is seen, is rather poor in protein but rich in sugar and allied bodies.

Parsnips.—The botanical name of the parsnip is *Pastinaca sativa* L. French, panais; German, Pastinake; Italian, pastinaca; Spanish, chirivia.

The parsnip is nearly related to the carrot in its appearance and also its properties. The root is usually long and straight and gradually tapering. It, however, often has other shapes, as is the case with the carrot and beet.

Composition.—

Water,	80.34	percent
Ash,	1.03	"
Protein,	1.35	"
Fiber,	.53	"
Sugar, starch, etc.,	16.09	"
Fat,	.66	"

The above data show that the parsnip is not much richer in nutrients than most of the roots grown, except in sugar and starch content. The large quantity of carbohydrates gives it its chief food value. These carbohydrates are not by any means all sugar and starch, but include a very considerable proportion of cellulose which is more or less digestible.

Peas.—The botanical name of the pea plant is *Pisum sativum* L. French pois; German, Erbse; Italian, pisello; Spanish, guisante.

The pea is quite as highly valued for table use as the bean, and, perhaps, is almost as extensively cultivated. The pea, however, is not usually eaten in the pod. It is probably indigenous to Central Europe, but has been so long cultivated that an exact history of its original distribution is not known. There, are many different varieties of the pea, but the one most highly prized is a small and very sweet pea. The larger variety does not have the palatability and other highly prized edible qualities that distinguish the smaller variety. The pea is found in the markets of the United States throughout the whole year, being grown under cover in the winter time. It becomes an abundant crop from early in the spring until very late in the autumn. Immense quantities of peas are preserved by canning, and in this condition they retain their edible properties almost without impairment throughout the entire winter. The pea is valued as a food in many forms.

Composition.—

	Water.	Ash.	Protein.	Fiber.	Starch, Sugar, etc.	Fat.
	Percent.	Percent.	Percent.	Percent	Percent.	Percent.
Green pea,..........	79.93	.78	3.87	1.63	13.30	.49
Dry pea,............	12.62	3.11	27.04	3.90	51.75	1.58

The above data show that the pea is a markedly nitrogenous food, especially the dry pea. Even in the green pea nearly four percent of its weight is protein.

A comparison of the composition of the pea with that of the bean shows that the pea is even more nitrogenous in character than the bean.

Potatoes.—One of the most important vegetables as well as food products in general is that class of products to which the name potato is given. The term strictly should apply only to that class known as white or Irish potato (*Solanum tuberosum* L.). The potato, as indicated by the name, belongs to a family of plants which is considered poisonous, but in the cultivated variety the poisonous principle has been practically eliminated. The potato belongs, essentially, to the starchy group of foods. If we assume, which is very nearly correct, that the average content of water in different varieties of potatoes at the time they are most suitable for edible purposes is 80 percent, it is found that at least three-fourths of the remaining solid dry matter is starch. The potato contains a trace of sugar and notable quantities of other carbohydrates than starch and sugar, namely, fiber. It also contains a very small proportion of nitrogen and mineral matter.

The potato is grown chiefly in temperate climates. It flourishes particularly well in the northern part of Europe, in England, Scotland, and Ireland, and in the northern portion of the United States. The northern part of Maine, especially, is noted for the production of potatoes of high edible qualities. It grows very well also in the southern part of the United States. The potato may be produced from seed, but that method of propagation has long since ceased to be practiced for agricultural purposes. The potatoes of commerce are produced from the eyes of the tubers. The best results in the growth of potatoes are secured in the loose somewhat sandy soil into which the roots of the plant can easily penetrate and which gives way readily to make place for the growing tuber. Hard, clay soils are unsuited to the growth of this vegetable. The planting is accomplished in the early spring after a thorough preparation of the seed bed by plowing to the usual depth, often subsoiling and reducing the surface of the soil to the proper tilth. The cuttings of potatoes or the whole potatoes are planted in rows to a depth of two or three inches, where they may sprout and even reach the surface at a temperature which at times may fall below the frost point on the surface of the soil. The leaf of the potato, when it has once appeared above the surface of the soil, is very susceptible to the action of frost. If killed at an early stage it may grow again without replanting. The potato is a crop which the farmer may plant early in the spring. There are other varieties which are planted later, even in the middle of summer, and produce good results. The planting season may continue over a period of two or three months. During the growth of the crop by the cultivation of the soil the surface is kept in good tilth, the weeds and grass prevented from growing, and the soil gradually drawn up around the growing tubers with the hoe or plow in the form of ridges. This heaping up of the soil tends to promote the development of the tubers, affording them a loose and more abundant bedding and a greater supply of plant food.

The greatest enemies to which the potato crop is obnoxious are found in the various forms of the potato bug (*Doryphora decemlineata*), which feed upon their leaves. To prevent the ravages of these insects it becomes necessary to dust over the leaves of the growing plants some powerful insecticide which will destroy the life of the insects feeding upon them. The active ingredient of these insecticides is usually arsenic. Fortunately the growing tuber does not absorb, so far as known, even traces of arsenic, or at least not more than the merest trace, which may be used for insecticidal purposes. It is quite impossible in most localities to secure a crop of potatoes without such treatment. The alternative is a constant inspection of the growing plant and the removal and killing of the bugs as they appear, but this is only practicable over very small areas as its general application would increase the cost of the product beyond the reach of the average consumer.

Yield.—Potatoes are produced in every state and territory of the United States. The statistics for the year ended December 31, 1909, show that the total area devoted to potatoes in the United States is 3,525,000 acres. The largest area in any one State is found in New York, namely, 438,000 acres, and the smallest area, aside from Arizona, not reported, is found in New Mexico, namely, 1000 acres. The yield of potatoes for the year is given as 376,537,000 bushels, the average yield per acre for the country being 107 bushels. The largest total yield was in New York, the largest yield per acre being reported from Maine, 256 bushels, while the smallest yields are found in some of the southern States. The average price per bushel for the whole country at the farm is 53.3 cents, and the total farm value of the crop $206,545,000. Generally potatoes command higher prices in some of the southern States, while the lower prices are found in Maine and the central west. The weight of a bushel of potatoes is 60 pounds. As the average amount of fermentable matter in potatoes grown in the United States is 20 percent, the total weight of fermentable matter in a bushel of potatoes is 12 pounds, which would yield approximately 6 pounds or 3.6 quarts of alcohol.

Composition.—Starch content: The quantity of starch in American grown potatoes varies from 15 to 20 percent. Probably 18 percent might be stated as the general average of the best grades of potatoes. In this connection it must be remembered that at the present time potatoes are grown in the United States chiefly for table use. Generally, only the imperfect or injured samples are used for stock feeding or for starch making, and this condition will probably continue as long as good edible potatoes bring a higher price for table use than can be obtained by utilizing them for starch or for feeding purposes.

Under the microscope the granules of potato starch have a distinctive appearance. They appear as egg-shaped bodies on which, especially the larger ones, various ring-like lines are seen. With a modified (polarized) light under certain conditions of observation a black cross is developed upon the granule. It is not difficult for an expert microscopist to distinguish potato from other forms of starch by its appearance, which is well shown in Figs. 39 and 40. Many of the granules are quite large, and most of them are ovoid in shape.

The quantity of protein in the potato is quite low compared with that of cereal foods; in round numbers it may be said to be 2.5 percent. The potato contains very little material which is capable of fermentation aside from starch and sugars.

Sugar content: Although the potato is not sweet to the taste in a fresh state, it contains notable quantities of sugar. This sugar is lost whenever the potato is used for starch-making purposes, but is utilized when it is used for the manufacture of industrial alcohol. The percentage of sugar of all kinds in the potato rarely goes above 1 percent. The average quantity is probably not far from 0.35 percent, including sugar, reducing sugar, and dextrin, all of which are soluble in water. In the treatment of potatoes for starch making therefore it may be estimated that 0.35 percent of fermentable matter is lost in the wash water.

One German author, Saare, claims to have found much larger quantities of sugar in potatoes than those just mentioned. The minimum quantity found by this author is 0.4 percent, and the maximum 3.4 percent, giving a mean of 1.9 percent. Ten varieties of potatoes used for the manufacture of industrial alcohol were examined in the securing of these data. It appears that some varieties have a greater tendency to produce sugar than others. The German variety known as "Daber" contains the smallest quantities of sugar, while the variety known as "Juno" contains the largest quantities. The percentages of sugar, as reported by Saare, however, are larger than those reported by other observers, and probably are larger than are usually found.

Average composition: Frazier, of the Cornell station, has collected analyses

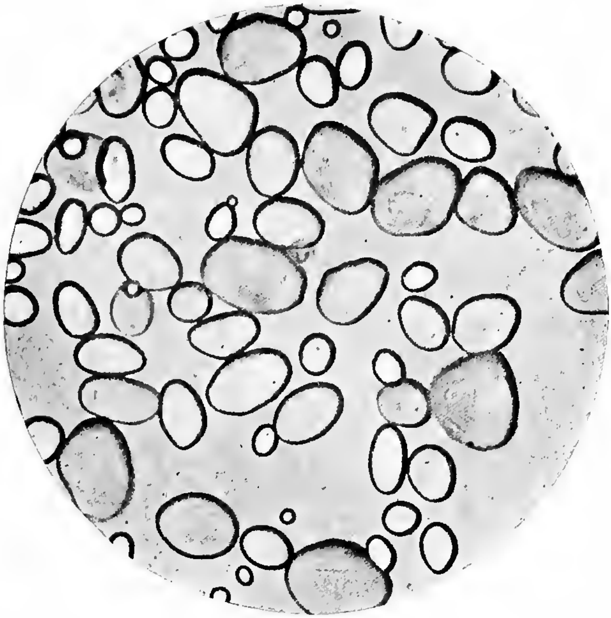


FIG. 39.—POTATO STARCH (× 200).—(*Courtesy Bureau of Chemistry.*)

FIG. 40.—POTATO STARCH UNDER POLARIZED LIGHT (× 200).—(*Courtesy Bureau of Chemistry.*)

of a large number of different varieties of potatoes, and finds them to have the following average composition:

Water,	75.00	percent
Starch,	19.87	"
Sugars and dextrin,	.77	"
Fat,	.08	"
Cellulose,	.33	"
Ash,	1.00	"

The following analyses show in detail the composition of potatoes from different localities:

Analysis of Maine potatoes: The Bureau of Chemistry a few years ago made an investigation in connection with the experiment station in Maine of the composition of potatoes grown in that state used for table purposes and for starch making. Some of the best varieties grown in different parts of the state were subjected to analysis, and the following results show them to be of quite uniform composition:

ANALYSES OF MAINE POTATOES.*

VARIETY.	WATER.	STARCH.	FIBER.	PROTEIN (NITROGEN X6.25).	ASH.	SPECIFIC GRAVITY.
	Percent.	Percent.	Percent.	Percent.	Percent.	
Hebron,	79.72	16.94	0.90	2.12	0.76	1.0604
Do.	78.13	18.59	.72	2.06	.78	1.0795
White Elephant,	76.81	19.96	.84	2.19	.99	1.0867
Do.	76.92	20.38	.90	2.31	.87	1.0742
Do.	78.74	15.96	.64	2.25	.92	1.0803
Do.	75.21	19.31	.61	2.12	.83	1.1058
Do.	75.88	18.81	.56	2.25	.96	1.0921
Do.	77.44	18.12	.63	2.06	.88	1.0906
Do.	75.56	18.14	.56	1.81	1.04	1.1129
Do.	78.13	18.62	.63	1.75	.98	1.0881
Delaware,	76.02	19.20	.61	2.06	1.01	1.0852
Do.	76.93	18.63	.61	2.19	.94	1.0904
Do.	75.72	18.63	.55	2.31	.95	1.0745
Do.	77.64	16.26	.61	2.56	.91	1.1120
Carmen,	76.87	18.03	.66	2.06	.90	1.0967
Do.	76.57	17.07	.59	2.38	.76	1.0804
Average,	77.02	18.29	.66	2.16	.91	1.0881

Analysis of Vermont potatoes: Analyses made in Vermont and published in the report of the Vermont Experiment Station for 1901 show an average content of starch considerably less than that above given, namely:

Water,	79.41	percent
Starch,	14.51	"
Sugars and dextrins,	1.44	"
Cellulose,	.36	"
Protein,	2.28	"
Ether extract,	.06	"
Ash,	1.26	"
Undetermined,	.68	"

* Maine Agr. Exp. Sta. Bul. 57, p. 147.

Composition of Potatoes used in France for Industrial Purposes.—The following is regarded in France as an average composition of the potato suitable for industrial purposes:†

Water,	71.00	percent
Starch,	18.00	"
Sugar, etc.,	1.06	"
Cellulose,	1.65	"
Protein,	2.12	"
Fat,	.11	"
Ash,	1.60	"

The total fermentable matter, as seen above, is a little over 19 percent, not allowing anything for the cellulose which is fermented. As a portion of the cellulose may also become a source of alcohol, it is observed that the average percentage of fermented matter in the French potato used for industrial purposes is not far from 20 percent.

The following varieties show a variation in starch content of 6.8 percent, the minimum being 15.9 and the maximum 22.7 percent:

Red starchy,	22.7	percent of starch
Shaw,	20.5	" "
Institute of Beauvais,	17.7	" "
Kernours,	17.9	" "
White Elephant,	16.0	" "
British Red,	16.0	" "
Giant Blue,	15.9	" "

Analysis of Potatoes from German Sources.—Average composition and starch content: The content of starch in potatoes examined in the laboratory of the Association of German Spirit Manufacturers during the year 1905 varied from 12.1 to 25.1 percent. Eleven percent of the total number examined contained between 12 and 14 percent of starch, 20 percent between 14 and 16 percent of starch, 13 percent between 16 and 18 percent of starch, 24 percent between 18 and 20 percent, 24 percent also between 20 and 22 percent, and 8 percent between 22 and 25.1 percent.

These data show that 56 percent of the total number of samples examined contained between 18 and 25 percent of starch. It is evident, therefore, that the general average content of starch in the potatoes used in the German distilleries is not far from 18 to 20 percent.

The mean composition of potatoes as given by three German authorities, namely, König, Lintner, and Wolff, is as follows:

AVERAGE ANALYSIS OF POTATOES BY THREE GERMAN AUTHORITIES.

CONSTITUENT.	KÖNIG. Percent.	LINTNER. Percent.	WOLFF. Percent.
Water,	75.48	76.0	75.0
Protein,	1.95	2.1	2.1
Fat,	.15	.2	.2
Starch and sugar,	20.69	19.7	20.7
Crude cellulose,	.75	.8	1.1
Ash,	.98	1.2	.9

† "Encyclopédie Agricole," E. Saillard.

The above data show the average content of fermentable matter in German potatoes, as determined by three of their leading authorities, to be about 20 percent. The potatoes used for the manufacture of alcohol in Germany are not of the variety raised for edible purposes. In a large number of experiment stations in Germany systematic efforts have been made for many years to grow a potato rich in starch without respect to its edible qualities. These potatoes are coarser in structure and less palatable than those grown for the table. The object of the cultivation of this class of potatoes is to produce as much starch and other fermentable matters per acre as possible. It is evident that our own experiment stations should undertake work of a similar character if the potato is to be used to any great extent in the manufacture of industrial alcohol. There is no doubt of the fact that success equal to that attained by the German experimenters will attend any systematic efforts of this kind in our country. Not only will larger crops per acre of potatoes be grown, but these potatoes will contain larger quantities of starch and other fermentable substances. If the crop of potatoes is to remain at the present average, namely, less than 100 bushels per acre, profitable returns for alcohol making can not be expected, either by the farmer or by the manufacturer. A much larger quantity must be grown and, if possible, at less expense, in order that encouraging profits may be realized.

Maercker, one of the most celebrated of German authors, states that in certain instances the potato in Germany reaches a very high starch content. Some varieties, in exceptional instances, have shown as high as 29.4 percent, 28.1 percent, and 27.3 percent, respectively. In warm, dry seasons potatoes often are found containing from 25 to 27 percent of starch. According to Maercker, the sugar content, including all forms of sugar, varies greatly. Perfectly ripe potatoes contain generally no sugar or only a fractional percentage. When potatoes are stored under unfavorable conditions, large quantities of sugar may be developed, amounting to as high as 5 percent altogether. In general, it may be stated that the content of sugar of all kinds will vary from 0.4 percent to 3.4 percent, according to conditions.

While potatoes grown thus to increase the content of starch are not generally used as food, yet they are nutritious but not as palatable as those grown especially for table purposes.

Ash analyses: The mineral matters which the potato extracts from the soil or from the fertilizers which are added thereto consist chiefly of phosphate of potash. The mean average composition of the ash of the potato is shown in the following table:*

Potash (K_2O),	60.37	percent
Soda (Na_2O),	2.62	"
Lime (CaO),	2.57	"

* Maercker, "Handbuch der Spiritusfabrikation," p. 99.

Magnesia (MgO)	4.69	percent
Iron oxid (Fe_2O_3),	1.18	"
Phosphoric acid (P_2O_5),	17.33	"
Sulfuric acid (SO_3),	6.49	"
Silicic acid (SiO_2),	2.13	"
Chlorin,	3.11	"

This analysis was made upon the so-called pure ash, deprived of its unburned carbon, and freed of sand and carbon dioxid.

Effect of fertilization on the yield and starch content: Experience in Germany has shown not only that liberal fertilization with nitrogen is favorable to the production of a large crop of potatoes, but also that this is accomplished without decreasing the percentage of starch therein. The following table shows the increase in yield, percentage of starch, and amount of starch obtained by nitrogen fertilization, the results being expressed in hectares* and kilograms:

EFFECT OF NITROGEN FERTILIZATION ON YIELD AND STARCH CONTENT OF POTATOES.

VARIETY OF POTATO.	WITHOUT NITROGEN.			WITH NITROGEN.		
	Starch.	Yield of tubers per hectare.	Yield of starch per hectare.	Starch.	Yield of tubers per hectare.	Yield of starch per hectare.
	Percent.	Kilograms.	Kilograms.	Percent.	Kilograms.	Kilograms.
Seed,	18.01	20,900	3,780	18.17	24,870	4,507
Champion,	21.33	19,510	4,152	21.48	24,470	5,233
Imperator,	19.00	22,560	4,235	18.70	26,830	5,007
Magnum Bonum,	18.41	19,170	3,522	18.07	22,510	4,057
Aurelie,	19.47	18,950	3,653	19.75	23,550	4,609
Reichskanzler,	22.78	14,300	3,236	22.61	17,250	3,875
Juno,	19.33	17,590	3,422	19.92	20,900	4,199
Amaranth,	22.47	16,180	3,619	22.84	18,310	4,188
Charlotte,	19.42	17,041	3,305	19.67	20,774	4,081
Gelbfleischige Zwiebel,	19.97	19,888	3,946	19.91	21,772	4,323
Dabersche,	21.82	17,377	3,778	21.80	20,313	4,399
Weissfleischige Zwiebel,	20.51	16,877	3,442	20.58	19,501	3,936
Schneerose,	18.84	19,653	3,724	18.66	22,343	4,186
Nassengrunder,	19.08	19,701	3,725	22.12	21,889	4,813
Gelbe Rose,	21.09	16,847	3,547	20.60	20,177	4,129
Hortensie,	17.72	22,416	3,907	17.45	26,381	4,532
Richter's Lange Weisse,	19.37	22,134	4,267	19.19	24,490	4,664
Rosalie,	18.27	19,866	3,557	18.25	22,186	4,003
Achilles,	21.02	18,886	3,962	20.93	20,913	4,376
Alcohol,	16.47	16,270	2,673	16.31	20,339	3,327
Average,	19.77	18,806	3,673	19.85	21,998	4,332

It is evident from the data given in the table that the liberal application of nitrogenous fertilizers increases the yield per acre of tubers and of starch to a very marked extent, although the average percentage of starch present is increased very little. Converting the average data given in the foregoing table into their equivalents in pounds per acre, we have the following

* 1 hectare=2.471 acres. 1 kilogram=2.205 pounds.

results: Without nitrogen—yield of tubers, 16,781 pounds per acre; yield of starch, 3,277 pounds per acre. With nitrogen—yield of tubers, 19,629 pounds per acre; yield of starch, 3,856 pounds per acre.

The following varieties of potatoes are considered in Germany the best for the manufacture of alcohol: Wohltman, Silesia, Agricultural Union, Athenena, Prince Bismarck, Richter's Imperator, and Maercker. A recent consular report on the potato as a source of alcohol in Germany shows the following yields per acre and percentages of starch:

YIELD AND STARCH CONTENT OF POTATOES GROWN IN GERMANY FOR ALCOHOL PRODUCTION.

VARIETIES.	YIELD PER ACRE.	STARCH.
	Kilograms.	Percent.
Professor Wohltman,	3,420	16.3
Iduna,	2,845	16.4
Topaz,	3,260	17.3
Sas,	3,990	18.3
Leo,	4,120	17.0
Richter's Imperator,	4,760	15.4
Silesia,	3,675	16.3
Professor Maercker,	4,280	14.5

Use of the Potato.—In addition to its value as human food the potato has other economical relations. It is used in many countries almost exclusively in the production of starch for the laundry and for general domestic uses.

The potato is not very extensively used for starch production in the United States except in the state of Maine and perhaps in one or two other localities. The starch of the potato has a particular value for use in the textile industry in the sizing of cloth. Practically all of the potato starch which is produced in the United States is devoted to that purpose, and for this reason it brings a higher price than the ordinary starch made of Indian corn.

Technique of the Production of Starch from Potatoes.—There is scarcely any manufacturing process which is more simple in its method than the manufacture of starch from potatoes. The process consists simply in the rasping or grinding of the potato to a fine pulp, which is afterward placed upon sieves in a thin layer and sprinkled with water which detaches the starch granules from the pulp matter, carries them through the sieve, and thus separates them from the fibrous portion.

It will be interesting to the general reader, on account of the importance of this product, to give a brief description of the method employed and the results obtained.

Potato Starch.—In this country potato starch is manufactured chiefly in Maine, Wisconsin, and Colorado. The factories are of a very primitive type, the machinery consisting of a rasper constructed usually by wrapping a wooden cylinder with sheet-iron punctured so that the ragged edges of the hole are on the exterior surface as shown in Fig. 41. Water is added at the time of rasping, and the starch pulp goes onto gauze shaking tables where the starch grains are washed through the sieve, as indicated in Figs. 42 and 43. The separated starch and water go into settling tanks. Where the starch has settled into a firm mass it is broken up and sent to the drying kiln. Potato starch is highly prized as a sizing in the textile industry.

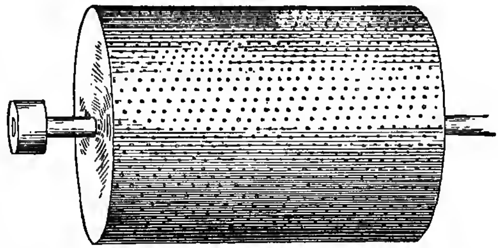


Fig. 41.—Rasping Cylinder for Making Starch.—(*Courtesy Department of Agriculture.*)

Use of the Potato in the Manufacture of Spirits.—A much more important technical use of the potato is in the manufacture of distilled spirits. Distilled spirits made from the potato are not generally used for potable purposes but are devoted to industrial uses. In the United States, very little if any distilled spirits are made from the potato. In Europe, however, especially in Germany, the industry is one of great magnitude. Practically all of the industrial spirits used in Germany and in many parts of Europe are made from the potato. The process is a simple one. The pulp of the potato, or

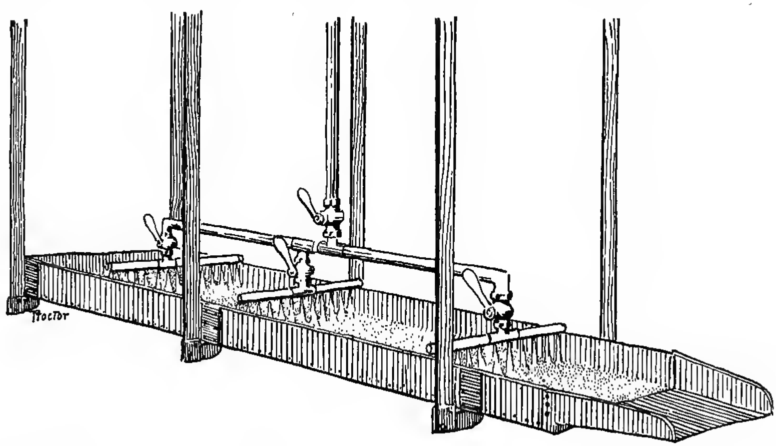


Fig. 42.—Shaking Table for Separating the Starch from the Pulped Potato.—(*Courtesy Department of Agriculture.*)

starch, separated therefrom is subjected to the action of malt or other diastatic action for the purpose of converting the starch into sugar. In some cases this conversion takes place by more strictly chemical means, namely, by heating the pulpy matter or the starch separated therefrom in a proper state of dilution, in contact with an acid at a high temperature and pressure.

Hydrochloric acid or sulfuric acid is usually employed for this purpose. The action of the acid converts the starch into fermentable sugar, namely, dextrose, a form of sugar differing in its quality and character from that produced by malt known as maltose. Both sugars, however, are fermentable to the same degree and produce, for equal quantities of sugar, the same quantity of alcohol. When the starch is converted into sugar by one or the other of these methods it is subjected to fermentation by an appropriate quantity of yeast which is of the same family as that used in the alcoholic fermentation of other saccharine products.

Special characters of yeast, however, are reserved for special purposes, since the variety of yeast determines to a certain extent the character of the secondary products which are formed during fermentation and thus determine the character, flavor, and aroma of the finished product. After the fermentation has been completed the residue is technically known as beer, and is subjected to distillation for the separation of the spirit.

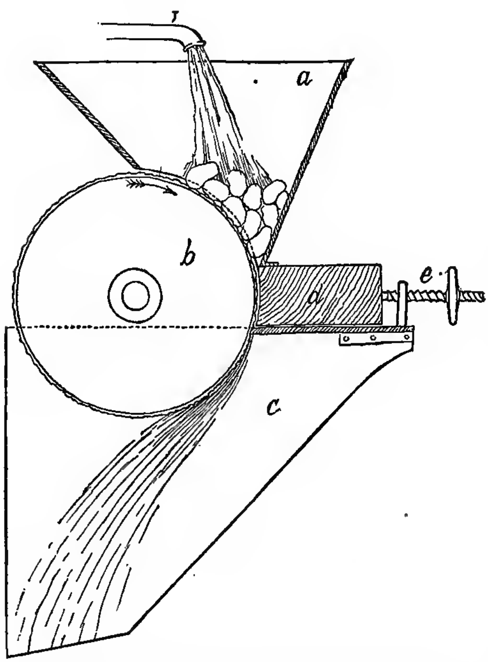


FIG. 43.—THE POTATO RASPING CYLINDER ARRANGED FOR WORK.—(*Courtesy Department of Agriculture.*)

A description of the process of distillation will be found in the second volume of this manual and is therefore omitted here.

Radish.—The botanical name of the radish is *Raphanus sativus* L. The French name is radis; German, Radies; Italian, ravanello; Spanish, rabanito.

The radish is a vegetable which is found throughout the whole year in all the principal markets of the United States, being grown under cover during the cold weather. It is ready for market within a short time after sowing, so that crop after crop can be grown during the year on the same soil. It is most highly prized when it is young, as it tends to acquire a pungent and bitter taste as it approaches maturity. The two principal varieties grown, as respects the roots, is the one having a long, tapering root, and the other a short, spherical bulb. The latter are more prized for eating purposes. There are many varieties grown.

Composition of Edible Portion.—

Water,	91.8	percent
Protein,	1.3	"
Fat,	0.1	"
Sugar, and other carbohydrates,	5.8	"
Ash,	0.7	"

Rhubarb.—The botanical name for rhubarb is *Rheum* L. The French name is rhubarbe; German, Rhabarber; Italian, rabarbaro; Spanish, ruibarbo.

Rhubarb is a vegetable which is widely distributed in the United States and grows generally very early in the spring. It is a highly acid plant, and is used chiefly as a sauce and for making pies. It requires a very large addition of sugar to make it palatable. It has medicinal properties which give it additional value. There are many varieties grown. It is a plant that is ready for use very early in the spring, being available in the farmer's garden almost before any other vegetable, and this makes it of still greater value.

Composition of the Edible Stem.—

Water,	92.67	percent
Ash,	.94	"
Protein,	.83	"
Fiber,	1.11	"
Sugar, starch, etc.,	3.26	"
Fat,	1.19	"

The above data show that the rhubarb is practically valueless as food and is chiefly condimental. In regard to its nutrients the fat is in a larger proportion than in that of almost any other succulent vegetable.

Squash.—Another variety of the gourd family which is highly prized as a food product is the squash. It is used in the same manner as the pumpkin, and is highly valued both as a food for man and domesticated animals.

Composition of the Flesh of the Squash.—

Water,	88.09	percent
Ash,	1.72	"
Protein,	.92	"
Fiber,	1.04	"
Sugar, starch, etc.,	8.05	"
Fat,	.18	"

The above data show that the squash is a much more nutritive substance than the pumpkin. In other respects it is little different in its composition, being only a dryer form of pumpkin.

Sweet Potato.—The vegetable known as sweet potato is known botanically as *Convolvulus batatas* L.

From the name it is seen that the sweet potato does not belong to the same botanical family as the potato itself. By reason. however, of its similar condition of growth and, to a certain extent, its chemical composition and uses, the term potato has, in this country at least, become to be universally applied to both, although the prefix "sweet" is quite commonly used with the sweet potato, whereas if any prefix is used with the potato, properly so-called, it is the word "white" or "Irish." The sweet potato is grown extensively in the United States and in other respects, agriculturally, may be regarded as complemental to the potato.

While the potato grows best in the northern parts of the country and in mild climates, the sweet potato flourishes in the greatest abundance in the southern and warmer portions. In respect to the character of the soil the two vegetables are quite similar, both doing best in a sandy or loose soil, provided it is sufficiently supplied with plant food for the use of the growing plant. The sweet potato is a thickened root, and is propagated almost exclusively by means of shoots called "slips."

Planting and Cultivation.—There is a very distinct difference between the planting of the sweet potato and that of the potato. The former are rarely planted in the field where the crop is to mature. It is quite a universal custom to plant the sweet potato in beds where the young growth can be forced both by means of artificial heat and by a generous mulch of highly nutritious soil. The plants can then be set very early in the spring and by the time they are ready to be transplanted to the field have acquired a considerable size. When ready for transplanting the seed bed is prepared with the same care as that required for the potato. The ridging of the rows, which in the case of potatoes takes place during cultivation, is accomplished in the case of sweet potatoes before planting. If the soil is moist and the temperature not too high the young plants are removed from the seed bed and set on top of the apexes in the formed rows. The cultivation of the field during the growth of the crop is sufficient to keep the surface in good tilth and prevent the growth of weeds, grass, etc. Care must be exercised in the cultivation not to draw the earth away from the ridges which have been formed, but to increase their size by drawing the earth more and more toward the apex of the ridge. The cultivation is continued until the growing vines practically cover the surface of the soil and thus form a natural mulch, which not only conserves the moisture and tilth of the soil but also prevents the growth of weeds and grass. The sweet potato, in respect of its flavor, is particularly sensitive to the influence of frost, also the leaves are more sensitive to frost than those of the potato. If a heavy frost is experienced before the tubers are harvested it is apt to impart an unpleasant taste to the potato and injure its edible qualities. For this reason, if it is not possible to harvest the potato before the advent of frost, it is advisable to cut the vines at the point where they emerge from the soil. When this has been done the injurious effects of the frost, above mentioned, are not experienced. In the southern portion of the country the sweet potato is often allowed to remain in the soil during the greater part of the winter, and, if the vines are removed, it keeps in excellent condition.

Yield and Composition of the Sweet Potato.—As has already been mentioned, there is a general resemblance, in so far as chemical and nutritive properties are concerned, between the sweet potato and the potato. The sweet potato is usually colored a yellowish tint, due to the distribution of more or less xanthophyll throughout its substance. The sweet potato also contains notable quantities of cane sugar, to which its name is due. It, however, contains large quantities of starch and fiber and small quantities of protein, resembling in this general manner the potato itself. The sweet potato has not been used in the United States for the making of alcohol. In the Azores great quantities of sweet potatoes are grown for this purpose, and make an alcohol of fine quality, which is used to a large extent in fortifying port wines. There are large areas in the United States, especially in the Southern States, where the sweet potato can be grown in great abundance. The experiments at the South Carolina station show that as high as 11,000 pounds of sweet potatoes can be grown per acre. The percentage of starch is markedly greater than in the white or Irish potato. In all cases over 20 percent of starch was obtained in the South Carolina sweet potatoes, and in one instance over 24 percent. As high as 2,600 pounds of starch were produced per acre.

In addition to starch, the sweet potato contains notable quantities of sugar, sometimes as high as six percent being present, so that the total fermentable matter in the sweet potato may be reckoned at the minimum at 25 percent. A bushel of sweet potatoes weighs 55 pounds, and one-quarter of this is fermentable matter, or nearly 14 pounds. This would yield, approximately, 7 pounds, or a little over one gallon of 95 percent alcohol. It may be fairly stated, therefore, in a general way, that a bushel of sweet potatoes will yield one gallon of industrial alcohol. The average yield of sweet potatoes, of course, is very much less than that given in the South Carolina reports, where heavy fertilization was practised. On plots to which no fertilizer was added the yield was about 8,000 pounds of sweet potatoes per acre, yielding in round numbers 1,900 pounds of starch. The quantity of sugar in the 8,000 pounds is about 350 pounds, which, added to the starch, makes 2,250 pounds of fermentable matter per acre. This will yield 1,125 pounds of industrial alcohol of 95 percent strength, or approximately 160 gallons per acre.

The yield of sweet potatoes in the above computation must be regarded as exceptionally high. A safer calculation will be based upon the yield of 100 bushels of sweet potatoes per acre, a little above the average of the yield of the potato, or a total of 5,500 pounds per acre. One-quarter of this amount is fermentable matter—about 1,400 pounds—which would yield, approximately, 700 pounds of 95 percent alcohol, or 100 gallons of 95 percent alcohol per acre. In addition to the sugar in the form of sucrose, or common sugar, which the sweet potato contains, there is also an appreciable amount of non-crystallizable sugars. The total sugars in the sweet potato have not been overstated in the above estimate. In fact, the contrary, rather, is true, since the two sugars together probably average about six percent of the weight of the potato. If the average quantity of starch in the sweet potato is 20 percent, which is rather a low estimate, the total fermentable matter in the sweet potato is 26 percent instead of 25 percent, as estimated above.

CHANGES IN COMPOSITION OF THE SWEET POTATO OF DIFFERENT VARIETIES ON STORING.*

FIRST LOT (November 28).

NAME OF VARIETY.	ORIGINAL.				AIR-DRY.				WATER-FREE.		
	Water.	Starch.	Invert sugar.	Sucrose.	Water.	Starch.	Invert sugar.	Sucrose.	Starch.	Invert sugar.	Sucrose.
	Per-cent.	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*
Georgia Buck	75.35	13.13	0.77	4.31	6.79	49.65	2.93	16.31	53.27	3.14	17.50
Bunch Yam	72.37	15.12	1.09	4.45	6.67	51.06	3.67	15.04	54.71	3.93	16.11
Do	67.99	19.58	.56	4.49	7.24	56.70	1.61	13.02	61.18	1.74	14.04
Horton Yam	70.29	15.06	1.05	6.23	6.24	47.52	3.31	19.67	50.68	3.53	20.98
Georgia Buck	71.56	14.35	.73	6.61	6.88	46.98	2.40	21.63	50.45	2.58	13.23
Vineless Yam	70.03	16.85	.54	5.01	7.90	51.78	1.67	15.40	56.22	1.81	16.72
Hanover Yam	76.16	13.61	1.10	4.22	7.37	52.89	4.29	16.40	57.10	4.63	17.70
Georgia Yam	70.01	18.87	1.00	4.08	7.57	58.17	3.07	12.59	62.93	3.32	13.62
Average	71.72	15.82	.86	4.93	7.08	51.84	2.87	16.26	55.82	3.09	16.16

SECOND LOT (January 7).

NAME OF VARIETY.	ORIGINAL.				AIR-DRY.				WATER-FREE.		
	Water.	Starch.	Invert sugar.	Sucrose.	Water.	Starch.	Invert sugar.	Sucrose.	Starch.	Invert sugar.	Sucrose.
	Per-cent.	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*
Georgia Buck	69.74	12.72	1.75	9.25	8.80	38.34	5.27	27.87	42.04	5.78	30.56
Bunch Yam	67.31	13.66	2.02	9.90	9.49	37.83	5.60	27.40	41.80	6.19	30.27
Do	67.29	13.83	2.40	9.43	10.00	38.04	6.61	25.94	42.27	7.34	28.82
Horton Yam	71.39	9.57	2.57	9.69	7.18	31.05	8.35	31.43	33.45	9.00	33.86
Georgia Buck	67.63	14.43	2.12	7.85	8.46	40.80	6.00	22.21	44.57	6.55	24.26
Vineless Yam	67.33	12.03	2.90	10.09	7.90	33.90	8.19	28.44	36.81	8.89	30.88
Hanover Yam	70.13	14.13	1.66	6.58	9.29	42.90	5.05	19.99	47.29	5.57	22.04
Georgia Yam	71.78	11.21	2.26	8.10	8.62	36.30	7.31	26.24	39.72	8.00	28.72
Average	69.08	12.70	2.21	8.86	8.72	37.40	6.55	26.19	40.99	7.17	28.68

Effect of Storage on Composition.—Experiments have shown that the quantity of starch diminishes and the quantity of sugar increases on storing.

* South Carolina Agr. Exp. Sta., Bul. 63, p. 25.

Further, it may be stated that in the varieties of sweet potatoes which are most esteemed for table use there is less starch and perhaps more sugar than are stated in the above examples. In one instance of an analysis made on the 7th of January of stored potatoes, the starch had fallen to a little less than 13 percent, while the sugars had increased to over 11 percent in less than six weeks. The total quantity of fermentable matter, however, as will be seen, had not been greatly changed, although there was probably a slight loss. In the southern agricultural work referred to, the yam and the sweet potato are considered together. The composition and the changes on keeping are well illustrated by the preceding data.

The above data apparently are sufficient to show the high value which attaches to the sweet potato and the yam, not only as edibles, but especially for the purpose of making alcohol. It is also seen that the sweet potato would not be a valuable material for making starch alone, because in starch making the sugar which the sweet potato contains is lost, whereas in the manufacture of alcohol the sugar and the starch, as well as any fermentable celluloses or gums in the potato, are utilized. The following table shows the extent to which this crop is grown in the United States:

ACREAGE AND PRODUCTION OF SWEET POTATOES (INCLUDING YAMS) IN THE UNITED STATES BY STATES, IN 1899, AS REPORTED BY THE TWELFTH CENSUS.

STATES.	ACRES.	BUSHELS.	STATES.	ACRES.	BUSHELS.
United States	537,447	42,526,696	Mississippi	38,169	2,817,386
Alabama	50,865	3,457,386	Missouri	9,844	743,377
Arizona	51	4,299	Nebraska	551	48,224
Arkansas	13,271	998,767	Nevada	5	923
California	1,607	239,029	New Hampshire	1	6
Colorado	20	2,291	New Jersey	20,588	2,418,641
Connecticut	2	130	New Mexico	47	6,180
Delaware	2,265	222,165	New York	73	8,681
District of Columbia	5	19,936	North Carolina	68,730	5,781,587
Florida	22,791	2,049,784	North Dakota	...	1
Georgia	70,620	5,087,674	Ohio	3,796	249,767
Hawaii	135	9,284	Oklahoma	2,512	195,799
Idaho	6	413	Oregon	27	2,825
Illinois	7,534	511,695	Pennsylvania	3,443	234,724
Indiana	3,989	239,487	Rhode Island	1	102
Indian Territory	1,064	80,364	South Carolina	48,831	3,369,957
Iowa	2,688	24,622	South Dakota	3	105
Kansas	4,570	74,810	Tennessee	23,374	1,571,575
Kentucky	14,178	925,786	Texas	43,561	3,299,135
Louisiana	27,372	1,865,482	Utah	40	4,958
Maryland	6,469	677,848	Vermont	4	306
Massachusetts	...	23	Virginia	40,681	4,470,602
Michigan	71	3,242	Washington	52	4,672
Minnesota	4	136	West Virginia	3,393	202,424
			Wisconsin	4	86

Average Composition of Sweet Potatoes.—The mean composition of varieties of sweet potatoes as determined by the California and Texas Experiment stations is shown in the following data:

	California Station (17 varieties).	Texas Station (21 varieties).
Water,	69.00 percent	70.27 percent
Ash,	1.15 "	1.14 "
Protein,	2.08 "	2.41 "
Fat,	1.00 "	0.99 "
Total sugars,	5.55 "	6.81 "
Starch, etc.,	24.23 "	24.00 "
Crude fiber,	2.62 "	1.26 "

Included in the starch of the above data are the substances soluble in boiling dilute acid and alkali.

Turnip.—The botanical name of the turnip is *Brassica napus* L. The French name is navet; German, Herbst-Rübe; Italian, navone; Spanish, nabo.

The turnip is grown very largely in the United States both as a vegetable and as a field crop for feeding purposes. The turnip used as a vegetable usually has a spherical bulb. It is a crop that grows late in the autumn. In the central part of the country it is usually sown as a field crop after the harvesting of some of the early crops as, for instance, early potatoes, and is ready for harvest late in the autumn, just before freezing weather begins. Grown as a vegetable, however, it is grown early as well as late. It has a spicy, pungent taste which makes it extremely palatable. It is sometimes eaten raw, but generally stewed.

Composition.—

Water,	90.46 percent
Ash,	.80 "
Protein,	1.14 "
Fiber,	1.15 "
Sugar, starch, etc.,	6.27 "
Fat,	.18 "

The above data show that the turnip is not a very nutritious vegetable and that its chief nutrients are carbohydrates.

Yam.—Another variety of edible root or substance belonging to the sweet potato class is known as the yam. It is also, like the sweet potato, particularly suited to growing in the subtropical or warm climates. The name yam properly belongs to a tropical root similar in appearance to the sweet potato but produced by various species of vines of the genus *Dioscorea*, not belonging even to the same family as the sweet potato. In the southern United States, however, the name yam is applied to certain varieties of the sweet potato with large coarse stems. It is cultivated extensively in the southern part of the United States, and is valued both as a food for man and specially for domesticated animals. The character of the soil, method of planting, and cultivation are the same as in the case of the sweet potato. It is particularly valued for fattening the variety of swine so common in the South, known as the "razor-back" hog. This animal does his own harvesting, and thus takes away from the agriculturist a portion of his labor which is not of the most agreeable kind.

Composition of Yams.—The composition of yams does not differ to any notable extent from that of the sweet potato.

Other Uses of the Yam and Sweet Potato.—In addition to the use of the yam and sweet potato for human food, reference has already been made to their value as food for domesticated animals. These bodies are particularly relished by hogs and cattle. The feeding of sweet potatoes or yams to milk cows insures a healthy condition of the body, and also imparts to the milk, cream, and butter the distinct amber tint which is regarded as a mark of excellence. Thus even in the winter months the butter which is made from milk produced in this way will have the light amber tint, which should distinguish it from the highly tinted artificially colored product which does so much to bring good butter into bad repute. Both sweet potatoes and yams are capable of yielding abundant supplies of distilled spirits. It is probable that under the new law which permits the use of denatured alcohol free of taxation in the arts an abundant supply of this product can be secured from the sweet potato and the yam. There are millions of acres of cheap land of a sandy character in the South Atlantic and Gulf states where potatoes and yams can be successfully grown under scientific principles of agriculture. If not needed for food purposes as above mentioned, the residue can be very profitably devoted to the manufacture of industrial alcohol.

Canned Vegetables.

It probably will excite no opposition to state that if fresh, succulent vegetables can be placed upon the table of the consumer they are to be preferred to the same kind of vegetables preserved in any manner. There are many circumstances, however, which render it difficult, if not impossible, to secure a regular supply of fresh, succulent vegetables upon the consumer's table. Those who possess abundant wealth may have a proper supply of vegetables at all seasons of the year without resorting to any preserving process other than the refrigeration incident to transportation. But the great majority of consumers must of necessity adapt themselves to the conditions of the market and the proximity of supply. Succulent vegetables properly harvested and refrigerated may be sent long distances, involving a considerable period of time, and reach the consumer in practically the same state of freshness and palatability as when first harvested. Owing to the exigencies of intermediary supply and the cost of transportation the great industry of keeping succulent vegetables by sterilization has been founded. Commonly vegetables prepared in this way are known as "canned" vegetables in this country and "tinned" in England. By availing himself of this process the consumer, even of moderate means, is able to command at all seasons of the year and in all locations an abundant supply of wholesome, fresh, succulent vegetable materials.

Principles and Process of Canning.—The sterilization of succulent vegetables depends upon the same principles as that of meat, already described. The decay of these vegetable substances is due to the action of certain ferments, either organic or inorganic, which act as agents in effecting the oxidation and decay of the organic material. If the action of these organisms can be prevented or inhibited the food material will remain for a certain length of time, not yet definitely determined, in an excellent, almost perfect state of preservation and without losing, notably, any of its nutritive or palatable properties.

It is not the purpose of this manual to describe the technique of canning, further than to illustrate the principles thereof in their relations to wholesome and nutritive food.

Selection of Materials.—It is of the highest importance in the canning industry, both for the reputation of the manufacturer and the health and comfort of the consumer, that the vegetables selected for canning be fresh, free from disease, and prepared in such a way that all adhering dirt or other foreign substances be excluded. The process of preparation for canning should begin as soon as possible after the harvesting of the vegetables, since a delay, especially at the high temperature which usually prevails at the time of canning, produces rapid deterioration, both as respects the quality of the vegetable and its flavor. After the proper cleaning and preparation of the fresh vegetables they are next subjected to the process of canning. It is then the vegetables are heated to a temperature of, or above, that of boiling water for a sufficient length of time to thoroughly destroy all the living germs and spores contained therein. The degree of temperature and the length of time of heating depend upon the nature of the vegetable substance, the size of its particles and of the package and the relative difficulty of preservation. Where only living organisms are present the proper temperature is that which will destroy the life of the germ. It is well known that spores from which fermentative germs may be developed are more resistant to the action of heat than the germ itself. When, therefore, spores of this kind are present, the temperature of heating must be higher and the time more prolonged, or, in lieu of this, the food should be heated on two or three consecutive days during which time any spores which may have been present will have developed into organisms and been killed. Some forms of vegetable materials are sterilized much more readily than others. For instance, the kernels of green Indian corn are of such a character and degree of hardness as to resist, with a considerable degree of success, the influence of heat on the life of the germs which they contain. In such cases it is customary to previously cook the vegetable substance before placing it in the cans. The cans should contain enough water to fill the interstices between the particles of vegetable matter. It is the practice in many instances to add a little salt and sometimes also sugar to this liquid. When the can is filled and closed the sterilizing is best completed by placing it in a strong boiler, which is then closed and heated by steam under a pressure of two or three atmospheres or even higher, namely, from 30 to 45 pounds and over per square inch. By heating under pressure in this way the development of any pressure in the can due to the production of steam is counterbalanced by the pressure without the can, so that a swelling or cracking of the can cannot take place. If the cans are heated in an open bath of water or brine it is customary to leave a small perforation in the top of the can through which the combined gas of the interior of the can may escape, and this vent is closed by a small drop of solder applied before or at the time of taking the cans from the bath. The canning of vegetables may also be done in a small way in the household and the principle on which this process is based is exactly the same as that set forth. The vegetables must be properly prepared, placed in the cans, and heated a sufficient length of time to destroy germs and spores, and the vent in the can stopped with solder. For family purposes the use of closed boilers for heating is not practical on account of the expense of securing such apparatus. All kinds of vegetables which are eaten in a cooked state can be preserved by the canning process. This cannot be applied, however, to those forms of vegetables which are eaten raw, such as lettuce, radishes, etc.

The principal forms of canned vegetables are described below:

Canned Beans.—Fresh, green beans used for canning purposes are generally preserved in the pod and not shelled, as is the case with the pea. The raw material should be selected with the same care as that which attends the selection of other vegetable products intended for preserving purposes. If the pods are small they may be placed whole in the can. Sometimes they are cut into small lengths in order to fit better in the package. As in the case of peas, the interstices between the particles of beans are filled by the addition of a sufficient quantity of brine of the proper strength to fill the can to the top. The process of sterilization is the same as that for other vegetable substances. Cooked beans are also preserved by canning and are often improperly called baked beans.

Composition of Typical Samples of Canned Beans.—The composition of typical samples of canned beans is shown in the following table:

Substance.	Water.	Fat.	Fiber.	Starch and Sugar.	Protein.	Ash.	Salt.
	Per-cent.	Per-cent.	Per-cent.	Per-cent.	Per-cent.	Per-cent.	Per-cent.
String beans,	94.33	.06	.51	3.03	.92	1.16	.80
Unstringed beans,	93.91	.07	.58	2.91	1.14	1.40	.92
Lima beans,	79.68	.30	1.16	13.24	4.00	1.62	.77
Canned baked beans,	67.19	3.18	2.46	17.88	7.14	2.15	1.03

As in the case of peas it is noticed that the beans in the hull are not a particularly nutritious vegetable in proportion to the quantity consumed and that the protein is the most valuable constituent in the dry matter.

Adulteration of Canned Beans.—The same adulterations may be found in canned beans as in canned peas. No additional remarks, therefore, are needed on this point.

Both canned peas and beans form condimental, palatable, wholesome, and desirable forms of these leguminous vegetables. The great cheapness with which they can be grown and the improved method of canning make it possible to produce these articles of food in quantities, and for a price which bring them within the reach of those even in the most humble circumstances.

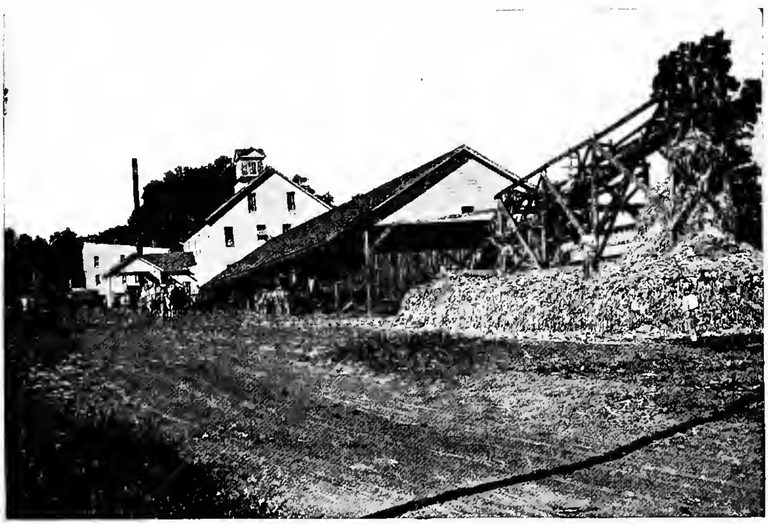


FIG. 44.—VIEW OF INDIAN CORN CANNING FACTORY, SHOWING ACCUMULATION OF HUSKS AND COBS.

As soon as the manufacturer restores absolute confidence in the purity of his products by completely excluding all adulterations the trade in these articles will be greatly increased and immensely greater quantities thereof consumed.

Canned Indian Corn.—In the United States a dish which is very extensively consumed throughout all parts of the country is one almost unknown in Europe, namely, succulent Indian corn. In the growth of Indian corn, at the period when the starch is formed in the grain and before it becomes set or hard, the immature grains make a palatable and excellent food product. In the appropriate season this delicious vegetable substance is eaten principally on the cob. A variety of Indian corn, which has already been described, namely, sweet corn, is the one chiefly used for edible purposes in this immature state. The Indian corn canning industry is a most extensive one in this country. The estimate of the number of cans of Indian corn produced during the year ended Dec. 31, 1905, is 13,939,683 cases of 24 cans each.

The principal centers of the industry are found in the New England States, especially in Maine, New Jersey, Maryland, New York, Ohio, Iowa, Illinois, and Indiana. By planting different varieties of Indian corn which mature at different ages and extending the planting season over a long period, the canning season, for instance, in Maryland, may be continued from the last of July to the advent of killing frost, usually the middle or last of October.

Technique of the Process.—The ears of sweet Indian corn are plucked from the stalk together with the husks, and brought in wagons in this condition to the factory. The husks are removed by hand or machinery and the ears passed through machinery by means of which, owing to the operation of knives, the grains are removed from the cob as evenly as possible. Care is taken not to cut too close to the cob so as to avoid mingling any of its particles with the corn. The separated grains are put into cans, treated with a sufficient quantity of water to fill the interstices, soldered, and subjected to sterilization. Nearly all of these operations are conducted by machinery. The sterilization is often effected by placing the cans upon an endless conveyer dipping into water or brine of the proper temperature and moving slowly through this bath at a pace determined by the length and temperature thereof, so that upon emerging the sterilization is complete. The cans may also be heated in closed vessels as already described. A typical view of a factory employed in the canning of Indian corn is given in the accompanying illustration, Fig. 44.

Composition of Canned Indian Corn.—The composition of canned Indian corn varies so greatly that it is only possible to give analyses of a somewhat general character, without attempting to express the extremes of composition which may be found. The immature Indian corn differs from the dry mature variety principally in the following respects: There is usually more sugar, as compared with the same amount of dry substance, and less starch and protein than in the matured variety. In fact, the constituent which is of chief value in the green Indian corn is the natural sugar which it contains. This natural sweetening cannot be imitated by the addition of sugar although the mixture may be made very sweet by this method. There is a delicacy of flavor and a peculiar palatability in the natural sweetness of Indian corn which must necessarily be due to the form of combination with other natural ingredients in which the sugar is found, and not solely to the sugar itself, which is practically ordinary sugar, sucrose, or its inverted product. While there is less starch in the immature kernel of Indian corn the starch is in a different physical state. In other words, it has not become solidified into aggregates of solid particles. The starch in this form also appears to be more palatable, and perhaps somewhat more digestible, than in its aggregate and solidified condition. As a nutrient the green corn is not so valuable by any means as its equal weight when dry. The percentage of water in green corn is many times as great as in the dry variety. For mere nutritive purposes, therefore, it would not be worth while to go to the trouble of canning green Indian corn. Its value is that which is attached to a succulent fresh vegetable, that is, it is condimental and hygienic as well as nutritive.

The mean analysis of many samples of canned sweet Indian corn is given below:

Water,	75.50	percent
Dry matter,	24.50	"
Oil and fat,	1.26	"
Cellulose,	.79	"
Ash,	.93	"
Salt,	.23	"
Protein,	3.51	"
Sugar and starch,	17.58	"

These data were obtained on samples bought in the open market, some of which had been artificially sweetened and to some of which starch had probably been added. The analysis of the fresh green corn is given on page 227.

Adulteration of Canned Corn.—Unfortunately many adulterations have been practiced in connection with the canning of Indian corn which, while not extensive or applicable to the great mass of material, have cast an unjust suspicion on the unadulterated product. The trade in this canned product would be vastly increased if the consumer could be assured that all forms of adulteration had been eliminated from the industry. The principal adulterants used are mentioned on page 228, but the following additional statements are pertinent:

Adulteration with Starch.—In order to make a more creamy liquid in the can the addition of starch has been largely practiced. There are two objections to the addition of starch to canned corn. In the first place it unbalances the ration and makes it more or less unwholesome. Starch itself is an unbalanced food product, but Nature has so distributed the starches in various foods as to present them in the most favorable form for digestion and assimilation, and when this natural balance is disturbed by artificial means the result is more or less injurious to the organs of digestion. There are many persons to whom starchy foods are not nutritious nor easily digested, and when persons of this kind consume canned Indian corn to which starch has been added their health may be injured. The addition of starch, therefore, is reprehensible for hygienic reasons. In the second place it is objectionable because it is deceptive, since the canned product has a richer and better appearance to the eye by this addition than it otherwise would have, and because more water can be used in the can.

Adulteration with Sugar.—It seems strange to speak of adulterating with sugar, and yet the addition of sugar without notice to canned Indian corn may become an adulteration. It has already been mentioned that the nature of Indian corn for canning purposes depends very largely upon its natural sugar content, and when corn of the proper sweet variety is selected the addition of other sweetening material is unnecessary. The use of sugar, therefore, in connection with canned Indian corn serves to cover up the defects of a corn whose natural sweetness is below the standard and thus the consumer is deceived. In addition to this, attention is also called to the fact already stated that no artificial sweetening, even with sugar, can produce that delicate and desired saccharine quality which the natural sweet corn possesses. The addition of sugar, therefore, to canned Indian corn without the notice thereof being plainly stated on the label is not to be encouraged.

Addition of Saccharin.—The use of benzoic sulfinid, or, as it is commonly known, saccharin, to canned corn unhappily is too often practiced. This body, which has no relation chemically or hygienically to sugar, which is not a food, which is wholly indigestible, and which the majority of experts regard as harmful to health, should never be placed in canned Indian corn, even if its use is stated upon the label. It produces an intense, but not agreeable, sweet taste and yet one which the unwary consumer would naturally attribute to the sugar present in the corn itself. Thus the consumer is deceived, and at the same time he is consuming a drug which has valuable uses in medicine but which should only be administered with the consent and by the advice of a physician. It is believed that under the scrutiny of municipal, state, and national inspection the use of saccharin in food products will disappear. Moreover, the name saccharin itself is misleading. It is an application of a word which by common usage is attributed to natural sugar substances to a substance which has no relation of any kind to sugar. The use of a word of this kind is evidently objectionable. The canner himself who uses this product often buys it under another name, which gives no indication of its true character.

Character of the Cans.—It is important that the containers in which canned vegetables are preserved should be of a character to yield no poisonous or injurious substance to the contents therein. What is said here in respect of canned Indian corn is generally applicable to canned products of all descriptions.

The approved standards for food products in the United States require the following properties for the containers:

"I. Suitable containers for keeping moist food products such as sirups, honey, condensed milk, soups, meat extracts, meats, manufactured meats, and undried fruits and vegetables and wrappers in contact with food products contain on their surfaces, in contact with the food products, no lead, antimony, arsenic, zinc, or copper or any compounds thereof or any other poisonous or injurious substance. If the containers are made of tin plate they are outside soldered and the plate in no case contains less than one hundred and thirteen (113) milligrams of tin on a piece five (5) centimeters square or one and eight-tenths (1.8) grains on a piece two (2) inches square. The inner coating of the containers is free from pin-holes, blisters, and cracks.

"If the tin plate is lacquered, the lacquer completely covers the tinned surface within the container and yields to the contents of the container no lead, antimony, arsenic, zinc, copper, tin, or any compounds thereof."

Souring and Swelling of Canned Corn.—In all cases where sterilization is not complete, or where spores remain undestroyed which afterward develop and produce various kinds of ferments, the canned corn spoils. The contents usually become sour and acquire a bad taste, and, in many cases, on puncturing the container gas escapes. The pressure of this gas in the can is sometimes great enough to produce a swelling, and hence the technical term "swelled" applied to cans of this kind. Various forms of ferments are active in producing these conditions. The common alcoholic ferment does not usually occur by reason of the fact that the yeasts which produce this form of fermentation are readily destroyed in the sterilizing process. Ferments which produce lactic, butyric, and other acids, and those which act upon the nitrogenous matter and tend to form various decomposition products are the most common.

In the case of canned corn and other canned vegetables the nitrogenous decomposed products are not usually very poisonous. On the other hand in the case of meat, and especially of fish and crustaceans, the degradation products from the nitrogen constituents of the food become poisonous and are known collectively under the name of ptomains.

If the sterilization has not been complete at the time of preparation, sweet corn, as well as other foodstuffs in similar circumstances, undergoes a kind of fermentation which renders it unfit for food. The fermentation is usually due to the greater vitality of spores and fungi, the real bacteria usually succumbing to the heat of preparation. Various gases beside carbon dioxid are produced, causing the corn to swell. All swelled goods should be rejected for food purposes.

Canned Peas and Beans.—These leguminous products lend themselves readily to canning purposes, and are preserved in great quantities in the United States in this way. Peas are always shelled before canning, and are harvested at a time to secure their greatest succulence. If the peas be too ripe they make a hard, unpalatable berry which detracts from the value of the canned product. The smaller variety of pea is preferred to the larger for canning, but, irrespective of size, they should be fresh, succulent, and not too mature. In the large canning factories the peas are harvested with machines such as are used for the cereals. The harvested material is passed through a shelling machine, by means of which the pods are opened and the peas separated. The rest of the pods, stalks, leaves, etc., are very valuable for cattle food or fertilizing purposes. Peas, before canning, should be separated into different sizes so that all those entering one can may be as nearly uniform in size as possible. This separation not only makes the contents of the can appear more attractive but also renders the sterilization more certain and easy. If large and small peas are put in the same can the heat of sterilization must be high enough and continue long enough to sterilize completely the large peas, and this might induce an over-cooking and impair the edible properties of the small ones.

The technique of the canning process is not at all different except in the preparation of the material, as described above, from that of other vegetable canning factories.

Composition of Canned Peas.—The composition of typical varieties of canned peas compiled from a large number of analyses is shown in the following table:

Water,	85.47	percent
Fat,	.21	"
Fiber,	1.18	"
Protein,	3.57	"
Starch and sugar,	7.79	"
Ash,	1.11	"
Salt,	.67	"

From the above data it is seen that the canned pea does not have a high nutritive value, considering its bulk. In the canned pea one of the principal food elements in the wet material is the protein which it contains, both the pea and the bean being very rich in this important food material.

Adulteration of Canned Peas.—The principal form of adulteration which is practiced in the canning of peas is the addition of sulfate of copper for the purpose of producing an intense green color. The delicate shade of green of the fresh, succulent pea tends to assume a yellowish tint on canning, and especially after keeping for some time. To such an extent does this oxidation of the natural chlorophyl go on that in many samples when opened, instead of a green, we discover a decidedly yellowish tint. When a copper salt, such as sulfate, is heated in contact with a nitrogenous substance, such as that which exists in the pea, a chemical combination is formed between the copper and nitrogenous bodies which has an intensely green tint.

It is often supposed that the sulfate of copper is added to canned peas to preserve their natural color. This, however, is not the case. The copper combination, as above mentioned, produces a dye of a very bright green hue. Sulfate of copper is a highly poisonous substance, and for this reason should be excluded from food products. It is only fair to state that those who use this material claim that in the form of the combination produced it remains insoluble during the process of digestion, and therefore the copper is inert. This claim is not sustained by the facts in the case. It is quite certain that the copper product forming the dye or the excess of the copper which is used remains in a state of very unstable composition which is easily broken up under the action of the acids and enzymes in the digestive organs.

It is greatly to the credit of the canners of the United States that the use of sulfate of copper has never come into use in this country.

Tests for Copper.—Fortunately the presence of copper in canned peas is easily ascertained even by the novice. If a portion of the peas be rubbed in a mortar to a fine paste and mixed with water acidulated with two or three drops of hydrochloric acid, a paste will be formed which on boiling will deposit copper on a clean metallic substance such as silver, steel, or iron. If a bright steel knife or a clean iron nail be placed in this paste, the surface will soon be covered with metallic copper. This simple test shows that the copper is not combined in any such permanent form as is claimed.

Saccharin.—The use of saccharin as an imitation of the natural sweet of the pea is, unfortunately, very largely practiced and is open to the same objections as were pointed out in the case of Indian corn. The use of sugar, salt, and other condimental substances in canned peas cannot be regarded as an adulteration unless deception results therefrom. It is claimed there is no special variety of pea distinguished by its content of sugar, and therefore the addition of sugar does not cause one variety of pea to imitate the properties of another. If this be true no deception is practiced, and, if the sugar is pure, no injury is done. In all cases of this kind, perhaps, it would be better if the manufacturer would plainly mark on the label the name of the added materials. Then there could be no question of the nature of the product.

Canned Tomatoes.—Next, perhaps, in importance to the industry of canned corn, is the preservation of tomatoes. Immense quantities of these goods are produced annually in the United States. The technique of the canning process is not at all different from that of canned corn. By reason of the pulpy condition of the material and its freedom from hard and impenetrable matter in the preparation for canning, the sterilization is accomplished in less time and with greater certainty than in the case of Indian corn.

Preparation of the Raw Material.—Only fresh, ripe, mature, and sound tomatoes should be used in the preparation of the canned goods. These are delivered by the farmer or contractor in baskets or otherwise to the factory. After sorting and rejecting all those that are unfit, the portions selected for preservation are treated in the usual manner to secure sterilization.

The skins, cores, and rejected portions of the tomatoes should be removed to a sufficient distance from the factory to prevent any bad odor or danger of infection.

Composition of Canned Tomatoes.—The chemical composition of canned tomatoes is shown in the following analysis:

Water,	93.59	percent
Fat,	.23	"
Fiber,	.60	"
Starch and sugar,	3.47	"
Protein,	1.29	"
Ash,	.66	"
Salt,	.14	"

From the above data it is seen that the tomato is not particularly valuable on account of its nutrient properties. It consists chiefly of water, and its value as a food product is principally condimental. It must not be denied, however, that it has that peculiar value which is possessed by all edible succulent vegetables and fruits, namely, it is a means of keeping the digestive processes in good form, preventing constipation, and promoting the general metabolic activity. In this sense it is seen that it is more than condimental. It also, of course, has a distinct food value, due chiefly to the carbohydrates it contains.

Addition of Sugar and Spices.—Sugar and other condimental substances are often used in the preparation of tomatoes. In this case it is doubtful whether the addition of pure sugar can be regarded in any sense as an adulteration if properly stated on the label. It is claimed that there is no distinction in the classification of tomatoes based upon their sugar content. If there were a variety of distinctly sweet tomato as distinguished from the ordinary field crop, then the addition of sugar to the field crop to imitate the sweet of the naturally sweet article would be an adulteration. But even in this case unripe or imperfect tomatoes may be used and sugar added to conceal inferiority. The use of common condimental substances, such as salt, spices, vinegar, etc., in the preparation of various products of tomatoes must be regarded as a perfectly legitimate operation.

Adulteration of Canned Tomatoes.—Fortunately there are few adulterations practiced in the case of canned tomatoes. The use of antiseptics to insure the conservation of the contents of the can was formerly practiced to some extent, salicylic and benzoic acids being the chief antiseptics employed. Since it has been made possible to easily, speedily, and economically sterilize the contents of the cans, the use of antiseptics is practically a thing of the past. The most common adulteration of tomatoes, perhaps, has been artificial coloring. The use of artificial coloring is resorted to solely for deceptive purposes. Where green or immature tomatoes are used, or other portions and parts of such fruits as are not suitable for the production of the highest grade products, the naturally red color of the tomato is imitated artificially, usually by the addition of cochineal or a coal tar dye. The use of artificial color in canned tomatoes has almost ceased in this country.

Saccharin is also sometimes used as an adulterant to imitate the properties of pure sugar.

It has already been intimated that green or unfit tomatoes or the residue of better grades are sometimes prepared and sold as the real article. This is a form of adulteration which is most reprehensible. Unfortunately, except in so far as the artificial color is concerned, this adulteration is not readily revealed by either chemical or microscopic examination, although the latter is exceedingly valuable in detecting certain forms of this kind of material. Only by a rigid inspection of the factories can this form of adulteration be excluded with certainty. The use of such immature fruits or scraps without notice to the consumer is, without doubt, an adulteration of an exceedingly bad type. If there be a desire to make a very cheap grade of the product out of these materials the nature of them should be plainly stated upon the label and then, perhaps, there would be a valid excuse for their appearance on the market.

Other Canned Vegetables.—There is no necessity to enter into the detail of the preparation of other canned vegetables further than to say that practically all vegetables which are offered on the market, except those which are necessarily eaten in a raw state, are preserved or can be preserved by the sterilizing process.

Tomato Ketchup.—A sauce which is used in large quantities in the United States and in other countries is known as tomato ketchup and is manufactured in many parts of the country. Tomato ketchup is the pulp of sound, ripe tomatoes mixed with various condimental substances and flavoring matters to make it palatable and desirable as a sauce. The character of flavor and condimental substances employed is left to the judgment of the manufacturer and the taste of the consumer, provided the materials are wholesome and sanitary. It has been claimed by some manufacturers that it is impracticable to place this desirable product upon the market without the use of chemical antiseptics. They admit, as in the case of the manufacture of fruit sirups, that tomato ketchup can be sterilized and kept properly until the bottle is opened for consumption; but, inasmuch as it is used in small quantities and a bottle of it lasts for many days, it cannot be kept in a proper state except by the use of such preservatives. The principal antiseptics which are used in connection with tomato ketchup are salicylic and benzoic acids.

Experience has shown that these claims are not of sufficient value to warrant the exception of tomato ketchup from the ordinary regulations respecting pure food. The habit of leaving a tomato ketchup bottle upon the table where the material adheres to the rim and becomes hardened to a gummy paste, serving as a pabulum for flies, does not appeal with any great force to the æsthetic sense relative to dining rooms. A ketchup bottle carefully opened and used in such a way as to avoid infection and then returned to the ice box can be kept for many days without danger of fermentation.

Artificial Colors.—Tomato ketchup is sometimes subjected to artificial coloring. This is done to imitate the color of the best raw material. If red, ripe, sound tomatoes are used no artificial color is necessary.

Use of Refuse for Making Ketchup.—It has been stated that the unripe, imperfect tomatoes at the time of harvesting are cooked in large quantities and treated with benzoic acid and stored in large containers until the canning season is over, after which this material is made into ketchup and artificially colored. Further statements have also been made to the effect that the skins, cores, and refuse of the cannery have been treated in the same way as indicated below. The proper inspection of the factories would exclude from the preparation of ketchup unfit material of the kind mentioned. It is doubtless true that when the people are finally convinced that the ketchup which is used is made of the best material and contains no artificial color or no harmful antiseptic, its use will be immensely increased.

A manufacturer of ketchup recently made the following statement respecting the utilization of the refuse matter at the cannery:

"We use in our standard catsup the peelings and small tomatoes. We preserve the pulp with four ounces of sodium benzoate to each 50 gallon barrel, cooked and whipped through a cyclone pulp machine. It takes two barrels of this stock to produce 60 gallons of catsup, and we use eight ounces more of sodium benzoate to preserve it."

If waste material of this kind is sound and wholesome, there can be no valid objection to its use if the product be preserved by sterilization alone, and offered for sale under its proper designation.

STARCHES USED AS FOODS.

Edible Starches.—Attention has already been called to the fact that starch is the principal constituent of many of the common foods, such as cereals and the different varieties of the potato and other vegetables. Starch is often separated from the part of the plant producing it, and is then largely consumed as food in practically a pure state. Starches used in this way are presented in the form of pudding or desserts of some kind, and are often richly spiced, highly sweetened, and often eaten with cream. Starch also appears in the market under other names such as tapioca, arrowroot, etc.

Arrowroot.—The plant which furnishes the substance known as arrowroot belongs to the natural family Cannaceæ and is principally native of tropical regions. The most important source of the arrowroot of commerce is the *Canna indica.* The starch of this plant exhibits in a strong degree certain characteristic qualities of starches derived from this natural family. The hilum in this starch is round and in some varieties double. The appearance of this starch under the microscope is shown in Fig. 45. The product of commerce is obtained from the rhizome and tubers.

Bermuda Arrowroot.—The Bermuda arrowroot is obtained principally from the *Maranta arundinacea.* This arrowroot is also produced very largely in St. Vincent and other West Indian localities. The granules of the starch are very much smaller than in the two species just described. The hilum is prominent, and frequently takes the shape of a well defined slit instead of the usual round spot. These arrowroots and those of South African origin are very extensively used for invalid foods where starchy foods are indicated,

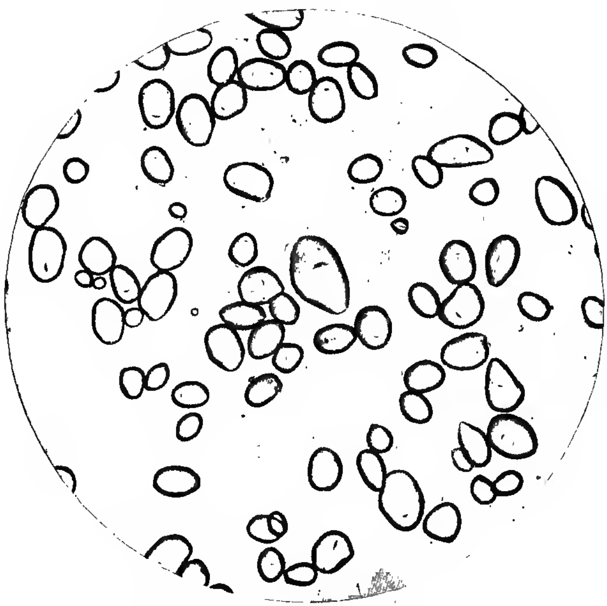


FIG. 45.—MARANTA (ARROWROOT) STARCH (× 200).—(*Courtesy Bureau of Chemistry.*)

which, however, is not very often the case. These starches form a firm and semitranslucent jelly-like body when heated to the boiling point in a small quantity of water. The term arrowroot is applied to starch from plants of the origin mentioned because the natives of the country producing them use the bruised rhizomes as a poultice for wounds caused by arrows.

Canna edulis.—This species of Cannaceæ also furnishes a starch of commerce nearly allied to the *Canna indica.* The common commercial name of this variety of starch is "Tous le mois." The starch granules of this species are rather larger than those of the *Canna indica,* and the concentric markings are more delicate and regular.

Madagascar Arrowroot.—There is also produced in Madagascar an arrowroot from a different form of plant, namely *Tacca pinnatifida*. It is not, however, of any very great commercial importance. A similar starch is made from the same plant in Otaheite.

Plantain Meal.—The plants of the natural family Musaceæ are important articles of food in many tropical regions, the plant yielding also, in addition to the starch, fibers suitable for textile use. The fruit of the *Musa paradi-*

FIG. 46.—A CASSAVA FIELD IN GEORGIA.—(*Photograph by H. W. Wiley.*)

saica is chiefly employed for this purpose. It is quite similar in its character to the fruit of the allied species, *Musa sapientum*, or common banana. The starch granules which make up the plantain meal are remarkable for their long and narrow shape. The lines marking their surface are only faintly distinguishable, and the hilum is small and somewhat indistinct. Plantain meal is not used to any very great extent outside of the country where it is produced.

Sago.—Another form of starch which has a high value as a food product is made from the natural family Palmaceæ. The palm starch or sago is consumed in immense quantities in many parts of the world, and is probably in importance only second to the starch derived from the cereals as human food. The starch granules are rather large and coarse, although very many small granules are found mixed with them. Some of the larger granules appear to be partially divided or broken. The hilum is distinct and very long. The sago of commerce is like a tapioca made from the palm starch. It has been subjected to heat while still moist in the process of manufacture, so that it is quite difficult, as a rule, to find the distinct starch granules of the palm in the commercial article. Sago is grown principally in the Moluccas and Sumatra.

South African Arrowroot.—There are many species of Marantaceæ cultivated in South Africa from which arrowroot is manufactured. They are of the same variety as that used in Bermuda and the West Indies. The cultivation of the plant has modified to some extent the action of the starch granules as originally found in the uncultivated plant. The starch granules in the cultivated variety approach more nearly a spherical form. The concentric lines are much more distinct and the hilum more prominent than in the wild variety.

Tapioca.—The most important of the starch products used as food is the tapioca. It is made from the plant belonging to the natural family Euphorbiaceæ, and is derived particularly from the variety of cassava plant known as *Manihot.* Attention has been called to the fact that many of the varieties of cassava plant are highly poisonous, due to the natural development during growth of hydrocyanic acid, one of the most violent of known poisons. This substance, however, is of quite a volatile character, and when comminuted cassava root is heated or boiled, all or at least the principal part of the hydrocyanic acid (prussic acid) disappears. None of it or at least not more than a trace is found in the food product tapioca. A comparatively sweet variety of cassava that contains but a small proportion of prussic acid is grown in Florida and Georgia. The appearance of a field of cassava is shown in Fig. 46. The tapioca of commerce is prepared by the separation of the starch in the usual way by grinding and washing with water. Before the starch becomes dry, in fact, while it still contains its maximum degree of moisture, it is subjected first to a low temperature which is gradually increased until the starch granules are disintegrated or agglutinated into a somewhat firm and gelatinous mass. The heat is then continued at the proper temperature until the water is nearly all driven off. The starch from this plant is sometimes known as Brazilian arrowroot.

The starch granules of the bitter cassava are very small and often angular in shape, although some of them appear as well rounded spheroids. The hilum is, as a rule, clearly distinguished. The microscopic appearance of the grains of cassava starch is shown in Fig. 47.

Adulteration of Tapioca.—The true tapioca should only be made from starch of the cassava. Any starch, derived from any source whatever, if taken in the moist state may be subjected to the same process of heating, and forms an imitation tapioca which possesses many of the physical and probably all of the edible properties of the genuine article. The substitution, however, of any of the other starches for that of the cassava is at least an imitation, if not an adulteration, of the genuine article.

Food Starches Derived from Cereals.—The starches which are derived from

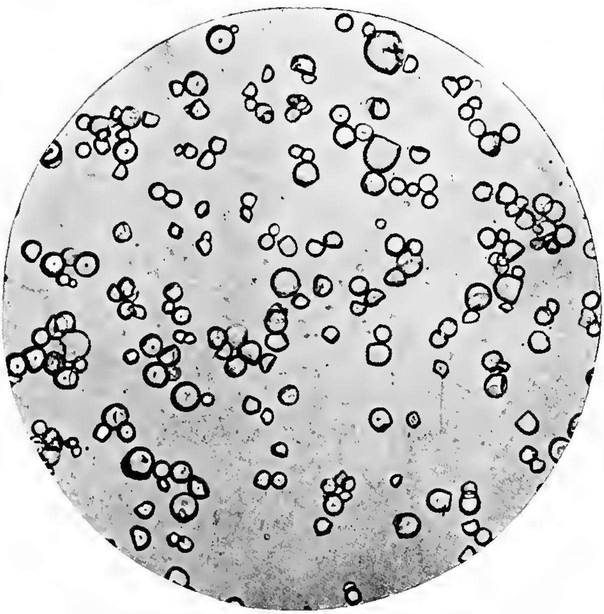


FIG. 47.—CASSAVA STARCH (× 200).—(*Courtesy Bureau of Chemistry.*)

the common cereals are also extensively used as food products, especially the maize starch in the United States. It is commonly sold as "corn" starch, and is largely used for the purpose already mentioned. It may be in its natural state or it may be previously submitted to the action of heat while still moist, so that it takes on the character of tapioca or sago. In the United States the Indian corn is practically the only cereal which furnishes the food starch in very large quantities, although rye starch is extensively used for this purpose in other countries.

The starches of certain of the legumes, such as peas and beans, have also been separated and used for food purposes. They are not, however, used to any such extent as would warrant any especial reference to them at this point.

Starch from the Peanut.—The peanut also yields a starch which has sometimes been separated and used for food purposes. The quantity so employed, however, is not large enough to be of commercial importance.

Food Starch Derived from the Potato.—Potato starch is also used very extensively for food purposes, either in its natural form or when subjected to heat while still moist, as in the preparation of tapioca and sago.

Adulteration of Starches.—The most common adulteration of starches is rather a misbranding than adulteration. The practice of adding inert white powdered mineral matters to starches is practically unknown in this country. Starch sometimes contains sulfurous acid used as a bleach in its preparation. This is an injurious substance and should be excluded from edible starches. The naming of a starch of one kind by the name of another and more valuable kind is simple deception. It is practiced to some extent in this and other countries. Starch itself may be used as an adulterant, as when maize starch is mixed with wheat flour or powdered starch mixed with granulated sugar. This kind of adulteration is quite unknown in this country. The selling of cheaper starches for tapioca and sago is more common than it should be.

CONDIMENTS.

Condiments other than Sugar, Salt, Vinegar, and Wood Smoke.—The principal condimental substances which are used for food are of vegetable origin and of a highly aromatic character. Condimental substances themselves may have food value, that is, contain digestible material which takes part in the metabolic processes. Their utility, however, and their value do not depend upon the amount of food which they contain, but upon their aromatic and condimental principles above mentioned. Condimental substances are used in a variety of ways, but in general it may be said that in an air-dried state they are reduced to a fine powder and employed in this form. Extracts may also be made from these condimental substances, either with water or usually with alcohol, and this extractable matter used as a condiment. The essential oils which they contain are also frequently separated by distillation, and in this purified and concentrated state are, after dilution with alcohol, used for condimental purposes. Peppermint oil is a type of this character of condiments.

It will be sufficient for the purpose of this manual to mention the principal condimental substances and refer for the character of their composition to the standards of purity established for them under authority of Congress in Circular 19, Office of the Secretary, U. S. Department of Agriculture.

Allspice, also known as pimento, is the dried fruit of the *Pimenta pimenta* L.

Anise.—The anise is a plant which grows from 14 to 16 inches in height. Its botanical name is *Pimpinella anisum* L. French, anis; German, Anis; Italian, aniso; Spanish, anis.

The anise produces abundant seeds, which are the principal condimental part. The seeds are used either directly in bread and other foods or especially in the manufacture of liqueurs and confections. Anise seed is one of the oldest of condimental substances of which historical account has been preserved.

Bay leaf is the dried leaf of the *Laurus nobilis* L. In a powdered form it is used as a condimental substance in food, but it is chiefly employed in flavoring alcohol in the manufacture of the material known as bay rum.

Capers.—The capers are obtained by drying the flower buds of the caper bush. The botanical name is *Capparis spinosa* L. French, caprier; German, Kapernstrauch; Italian, cappero; Spanish, alcaparra.

The caper is a plant which is a native of southern Europe of shrub-like proportions, growing to a height of from three to five feet. The flower buds are gathered when they are about as large as peas and are preserved by pickling in vinegar.

Caraway.—This is a plant which is native to Europe, is either annual or biennial, and belongs to the botanical species *Carum Carvi* L. French, carvi; German, Feld-Kümmel; Italian, carvi; Spanish, alcaravea.

The seeds contain the aromatic principles which make the caraway valuable as a condiment. The plant often grows wild. The roots have some value as food and are also highly spiced, but are seldom eaten. The seeds are used very largely for flavoring bread, especially among the Germans. They are also used in certain varieties of cheese, especially that made in Holland. Often they are found in certain candies and other confections.

Cassia is that variety of cinnamon obtained from other species of cinnamon than *Cinnamomum zeylanicum*, and is not so highly valued for condimental and other purposes as the true cinnamon.

Cassia buds, which are often used for condimental purposes, are the dried immature fruit of any species of the cinnamomum plant. The cinnamon, as it is offered for condimental purposes, is usually finely ground, and the same is true of cassia.

Celery Seed.—The seeds of celery are highly prized for condimental purposes, either as seeds or in the form of an extract. Both are also often recommended for medicinal purposes.

Cinnamon.—The cinnamon is the bark of various species of plants belonging to the genus *Cinnamomum*. The true cinnamon is derived solely from the bark of *Cinnamomum zeylanicum* Breyne.

Cloves.—Cloves are dried buds of the *Caryophyllus aromaticus* L. They are used either in the original dried state or as a finely ground powder.

Coriander.—The aromatic principles of coriander employed for condimental purposes are found in the dried seeds of the *Coriandrum sativum* L. This is a plant which is indigenous to southern Europe, growing from two to two and a half feet high. The seeds are used in the manufacture of liqueurs and for seasoning a great number of culinary preparations. It is stated by some authorities that the leaves are used for condimental purposes, but this is not the case. The leaves as well as the other green parts of this plant have a very unpleasant odor from which the name of the plant is derived. This odor is of a character which would exclude the leaves from use for condimental purposes.

Cumin Seed.—The cumin plant (*Cuminum cyminum* L.) is thought to be indigenous to Egypt. It is an annual plant, sometimes growing from four to five inches high. The seeds are the aromatic part and are used for condimental purposes. They have a hot, acrid taste and a strong aromatic flavor. They are used chiefly for flavoring soups and in the manufacture of pastry of all kinds. They are also found in many kinds of liqueurs.

Dill.—The dill plant (*Anethum graveolens* L.) is indigenous to southern Europe. It is an annual plant and grows from two to two and a half feet high. The seeds, which are the condimental part of the plant, are flat and have a strong and bitter flavor. They are used in this country principally for flavoring a kind of pickle known as the dill pickle.

Fennel.—The fennel plant (*Fœniculum fœniculum* L.) is indigenous to southern Europe. It grows both wild and under cultivation. The common garden fennel is biennial in its habits. The seeds contain the condimental properties of the plant, and the seeds of the cultivated fennel are usually about twice as long as those of the wild variety. They are flat on one side and convex on the other and crossed by thick yellow-colored ribs. The seeds are used chiefly in the manufacture of liqueurs.

Ginger.—The ginger is the root of the plant *Zingiber zingiber* L., and is one of the most highly prized of the condimental substances. It is a plant which naturally contains a large amount of starch, which forms nearly half of its weight in the dried state. The roots are often sent into commerce covered with lime, either for the purpose of preserving them or bleaching them. This is such a common condition that the limed ginger or bleached ginger is recognized as a legitimate article of commerce.

Mace.—The mace of commerce is composed of the dried arillus of *Myristica fragrans* Honttyn. Mace contains a large quantity of fatty substance, usually not less than 20 nor more than 30 percent of its total weight. There are several varieties of mace on the market, the principal one being Macassar mace, which is obtained from the dried arillus of *Myristica argentea* Warb. The Bombay mace is derived from the dried arillus of *Myristica malabarica.*

Marjoram is the dried leaf of the plant known by the botanical name of *Majorana majorana* (L.) Karst. or *Origanum vulgare* L. This plant is a native of Europe and is a very common wild plant in France, especially on the borders of the forests. It is also extensively cultivated. It is a perennial. The leaves of the plant are the condimental portions. A plant known as mountain mint is frequently sold as marjoram and has some of its condimental properties.

Mustard.—The mustard seed is derived from various species, distinguished largely by the color of the seeds. For instance, the white mustard is the seed of *Sinapis alba* L., the black mustard the seed of *Brassica nigra* (L.) Koch, and the black or brown mustard the seed of *Brassica juncea* (L.) Casson. The mustard is a widely distributed plant probably indigenous to Europe. It grows extensively wild and is also largely cultivated. The mustard seed forms one of the most important condiments of commerce. The mustard is often ground before it is sold, and frequently it is mixed with other spices and with oils and is known as prepared mustard. This latter variety is subjected to all kinds of adulterations, frequently containing very little mustard but with enough turmeric to give the preparation a yellow color resembling that attributed to the pure article. Prepared mustard should be a thick paste composed largely of ground mustard seed together with salt, spices of different kinds, and vinegar. It may also be ground in oil.

Nutmeg.—Nutmeg is the seed of *Myristica fragrans*. The seed is sent into commerce with a thin coating of lime, which, of course, must be removed before the nutmeg is used. It is principally used as the unground nut and by grating it into the food which is to be flavored at the time of use. The nut thus retains its flavor much better than when all ground at once and kept for some time. There are many varieties of nutmeg on the market, the principal ones being the Macassar, Papua, male, and long nutmegs. These are all the dried seeds of the *Myristica argentea*.

Pepper.—Pepper is one of the most important of the principal aromatic condimental substances. There are many standard varieties which are known to the trade and which are derived from distinct botanical species. The principal varieties are black pepper, white pepper, and paprika pepper. Black pepper is the dried immature berry of *Piper nigrum* L. White pepper is the dried mature berry of *Piper nigrum* L. from which the outer and the inner coatings of the seed have been removed. Paprika pepper is a red pepper of very mild aromatic qualities grown chiefly in Hungary and in Spain.

Cayenne pepper is a very active aromatic red pepper which is the dried fruit of *Capsicum frutescens* L. or *Capsicum baccatum* L.

The red peppers, therefore, may be divided into two distinct classes, namely, cayenne or hot, acrid pepper and the paprika or mild-flavored pepper. There is another variety of pepper known on the market as long pepper which is the dried fruit of *Piper longum* L.

Saffron is the dried stigma of *Crocus sativus* L.

Sage is a common garden plant which is very extensively used for condimental purposes, belonging to the species *Salvia officinalis* L. Sage is used very extensively by the housewife in the preparation of domestic sausage, and is perhaps more commonly used in meat products of this description than in other foods.

Savory or *summer savory* is a preparation from the leaf, the blossom, and tender tips of the branches of *Satureja hortensis* L.

Sweet Basil.—This plant is indigenous to India, growing usually about one foot high. The botanical name is *Ocymum basilicum* L. French, basilic grand; German, Basilikum; Italian, basilico; Spanish, albaca.

The leaves of the plant are the aromatic part and are extensively used for condimental purposes of different kinds. There are many varieties of basil in use.

Thyme.—Thyme is a plant indigenous to southern Europe and belongs to the botanical species *Thymus vulgaris* L. It is a perennial plant and grows in the form of a small dwarf shrub. The plant may be propagated either by cuttings or may be grown from the seed. The leaves and young shoots of the thyme may be used for condimental purposes. Some other species of the thyme are also used for condimental purposes, especially the varieties known as lemon thyme and mother-of-thyme.

Vegetable Flavoring Extracts.—In speaking of condimental substances it was stated that they were either used directly in a state of fine subdivision for flavoring purposes or their extracts were employed. The use of the extract is often more convenient than the use of the powdered material, and, also, it secures a more even distribution of the flavoring principal throughout the food product. It is doubtful, however, if for really condimental purposes there is any advantage in the use of the extracted materials. Nevertheless there are many food products in which it would be inconvenient to use the powdered aromatic substance itself and the flavoring extract has become established as a legitimate article of a condimental nature.

All the common extracts used in foods are described in the standards of purity established by the Secretary of Agriculture by authority of Congress, and issued as Circular 19.

FRUITS.

Definition.—Under the term "fruit" is included the edible products of many trees and shrubs. The term "fruit" in its general sense can be applied to any kind of a food product, as for instance the fruit of the farm, the fields, and the forest, but in a restricted sense, as it will be used here, it is applied to the class of orchard products represented by apples, peaches, pears, etc. Fruits, in a general sense, include also that class of wild or cultivated edible bodies known as berries. The term "berry" is restricted in its present sense to the products of certain small shrubs or vines, such as gooseberries, blackberries, raspberries, etc. The fruits that grow upon small bushes, such as the currant and gooseberry, occupy an intermediate position between the orchard fruits which have been mentioned and berries. Orchard fruits are conveniently divided into large and small fruits, the large fruits being represented by the apple, pear, peach, quince, etc., and the small fruit by the cherry and plum. Fruits were doubtless among the earliest foods of man, and this leads to another classification of fruits, namely, wild and cultivated. Wild fruits, at the present time, do not include any large proportion of human foods. There are certain trees growing wild, such as the mulberry, the wild cherry, and others, which produce delicious fruits, usually of small size. The term "fruit" as used herein does not include that very valuable class of foods known as nuts, which is considered under a separate classification.

General Characteristics of Fruits.—The general characteristics of fruits include their color, flavor, odor, and nutritive properties in so far as we are concerned with them in this manual. They are composed very largely of water, perhaps 80 percent or more. The solid matter consists of the usual cellulose structure of vegetable bodies, sugars, gums, organic acids, and mineral matters. Fruits are all succulent, that is, by reason of their high content of water, composed chiefly of matters in solution which constitute their juices. All fruits, therefore, when subjected to pressure yield a juice which contains the principal portion of their dietetic constituents. The study of the composition of the fruit juices would, therefore, naturally accompany a study of the fruits themselves. The chief characteristics of fruit from a dietetic point of view and also as to palatability are derived from their sugars and acids. The taste also is largely due to these components. In addition to this the fruits contain aromatic substances belonging to the class of essential oils and compound ethers which give to them the agreeable odor which adds so much to their value. Fruits are naturally colored and these colors, to which the eye is accustomed, become marks of distinction and excellence in many cases. The prevailing colors of fruits are red, yellow, and green. All shades of colors, however, are represented by the mingling of the primary tints. Certain colors are associated with certain fruits as, for instance, red with the cherry, raspberry, etc., green, red, and yellow with apples, and shades of red and yellow with peaches. These colors are due to the different conditions of the chlorophyll or vegetable coloring matter which the skin of the fruit contains. The three principal color tints which are produced are known as chlorophyll (green), xanthophyll (yellow), and erythrophyll (red). The mingling of these three distinct colors in the plant coloring matter forms the various tints which are seen in fruits and which render them so attractive to the eye.

The sugars in fruit include both the common sugar (sucrose) and invert sugar, which contains equal quantities of dextrose and levulose. As the sugar is more or less abundant in proportion to the other ingredients the fruit is more or less sweet. The different fruits contain different quantities of sugar,—the richest perhaps is the grape which often in a state of complete maturity may have from 25 to 30 percent of sugar. Apples contain from five to 15 percent of sugar, and peaches and pears somewhat less. In fact this range in sugar will cover nearly all the fruits, large and small, as well as most of the berries. The quantity of sugar contained in each of the fruits will be especially noted in treating of them individually. One of the most important constituents of fruit from a palatable point of view is found in its organic acids. These vary in different classes of fruits. The most common organic acid in fruit is malic, which is the chief acid in the apple and allied forms. In citrus fruits, such as the lemon and orange, citric acid is the principal organic acid. In grapes the principal organic acid is tartaric. More than one of these acids is, however, usually contained in a single fruit, and other organic acids than those named are found in small quantities in various fruits. The three mentioned may be regarded as the typical acids in fruits. These acids, if prepared chemically and administered in a pure state, have practically no food value at all, and cannot be considered as wholesome material to place in the stomach. When, however, they are eaten in their natural state in combination with the potash and other bases which fruits contain, and mingled, as Nature has done, with the other constituents, they add not only to the palatability but also to the wholesomeness of the product. This is only another illustration of the fact that natural products are often wholesome and desirable where artificial products of the same kind chemically are hurtful and undesirable. Many fruits contain considerable quantities of a carbohydrate allied to some extent in its composition to sugar and starch but which has the property of setting to a semi-resilient mass known as jelly. This constituent in fruit is known as pectin or pectose and is present in greater or less quantities in almost all fruits. It is by the utilization of this component of fruit that the jellies which are so common an article of food are prepared. While in its physical properties the jelly of fruits has some resemblance to the gelatine or jelly of animals, its chemical composition and nutritive values are entirely different. The gelatine or jelly of animals is essentially a nitrogenous product while the pectin or jelly of fruit is essentially a carbohydrate product. The two, therefore, are not to be confounded.

Nutritive Uses.—The edible fruits are not only valuable on account of the nourishment they contain but particularly so because of the general effect which they have upon the digestive operations. Their judicious use is conducive to health in many ways. The fruits are mildly laxative, as a rule, although there are some exceptions to this. For instance, in some berries, like the blackberry, the quantity of tannin present is sufficient to cause a styptic or binding action. While all the fruits contain tannin it is usually not in such proportions as to produce a constipating effect. On the other hand the combination of the acids, bases, pectins, and sugars favors a free and natural progress of the food through the alimentary canal. The entire withdrawal of fruit from the dietary, even if the nourishment it supplies be provided in some other way, would work great damage to health. There are certain dangers, however, to be avoided in the general use of fruit. Immature and imperfect fruits are unwholesome. Fruits are often subjected, moreover, to infection with eggs of various kinds of insects, and these organisms and the larvæ or eggs thereof may be introduced into the stomach with more or less injurious effects. In the eating of fruit, care should be exercised in the inspection and proper preparation of the article; it should be free from infection, decay, and insect life. The natural condition in which fruit is eaten is in the raw state, and in general it may be said that this is the more wholesome and preferable way of eating it. On the other hand the cooking of fruit sterilizes it and makes the consumer secure against any infection from bacteria and insect life, and in some ways promotes to a certain degree the digestive processes. This is especially true of fruits of a hard or unyielding nature. Cooked fruits, as a rule, may be considered less desirable than the natural article, but they deserve mention on account of their freedom from infection, wholesomeness, and general dietetic value. Some fruits, such as apples and pears, contain notable quantities of starch, especially in the immature state, and this disappears to a greater or less extent during the process of ripening. At the period of complete maturity the starch is reduced to a minimum and the sugar in the fruit reaches a maximum. After this period the fruit begins to lose in dietetic value, due to the natural process of decay, which is not even entirely checked by placing the fruit in cold storage. The sugar gradually ferments and disappears. The fruit becomes more spongy and less palatable and its general properties are impaired. Other fruits, such as the orange and lemon, berries, etc., contain little or no starch at any period of their growth. By careful storage the period of maturity may be prolonged for weeks or even months, and thus the fruit made available over a very much longer period than would otherwise be the case. Under the existing conditions of communication with all parts of the world it is not impracticable for even those who are not blest with wealth to have a daily supply of fresh-fruits grown in different parts of the world. In temperate climes fresh fruits are available from June until May of the following year, either furnished directly from the orchard or properly preserved by storage.

Apples.—The apple is one of the principal fruits in the market both because of its crop value and its general properties.

It is the most abundant as well as the most valuable of fruits. The apple is grown practically in all parts of the United States, but there are some localities in which apple trees are grown with special success. Among the states which are famous for apple growing may be mentioned New York, Virginia, Michigan, and Missouri.

The varieties of apples are so numerous that it will be useless to attempt to mention them. Some of the most important are the Ben Davis, the Pippin, the Winesap, Jonathan, Rhode Island Greening, York, Albemarle Pippin, Clayton, Early Harvester, Sweet June, Tompkins King, Northern Spy, Russet, Yellow Bellflower, etc.

Acidity of Apples.—One of the chief points in the palatability of apples as well as in their general character is their acidity. While apples are not relished when too sour they are as little relished when too sweet. The sugar and acid in apples are the chief factors in their palatability, not excluding the delicate flavor imparted by essential oils and ethereal substances which, though present in such small quantities as not to be measured chemically, nevertheless are highly important in making up the total effect of palatability and wholesomeness. The chief acid in apples is malic. It exists during all periods of the growth of the apple, but is more apparent in the green and immature state than in the ripe fruit. The relative quantity of malic acid in respect of sugar and starch is given under the heading of "Behavior of Apples During Storage."

Adulteration of Apples.—There is, of course, no adulteration of apples in their natural state except the attempt which is sometimes made to deceive the purchaser respecting the character of the whole package by placing the best and most attractive fruit on the top. This is such a well known practice, though regrettable, as not to demand any particular comment. The purchaser who has his own interest at stake will usually inspect the bottom as well as the top of the package before buying. The chief forms of debasement are those which are not practiced with any attempt to deceive. They consist in offering apples which are bruised by carelessness in gathering, or which are infected by insect life. In fact the greatest damage to which the apple is subject is that of the ravages of insects. There are certain kinds of insects which naturally breed in the apple. The egg is often laid in the early development of the fruit and by the time the apples are ready for consumption the larvæ stage has been reached and the worm has produced ravages to a great extent which are often not indicated by any external appearance. It is evident that the farmer cannot be held responsible in all cases for this condition of the fruit. Nevertheless it is only fair to state that in the modern development of the spraying industry the ravages of insect pests can be restrained and controlled, if not entirely prevented, by the proper spraying of the fruit. This spraying introduces another danger which cannot be forgotten, namely, the remaining upon the surface of the fruit of some of the spraying material itself. If present at all this material is apt to be either at the point of the junction of the stem with the fruit or at the opposite extremity of the apple. For this reason the fruit when eaten raw should be peeled in order that any remaining particles of the poisonous material used in spraying may be removed. It is to the interest of the merchant to present fruit of this kind in the most attractive form, by the exclusion of bruised, rotten, or infected apples and the offering of the sound, ripe fruit in as presentable a condition as possible.

Composition of Apples at Various Stages of Maturity.—The following table shows the analysis made of one variety of apple, the Baldwin, at various stages of maturity:

Condition.	Solids.	Invert Sugar.	Cane Sugar.	Starch.	Acidity as Malic Acid.	Ash.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Very green,..................	18.47	6.40	1.63	4.14	1.14	0.27
Green,......................	20.19	6.46	4.05	3.67	....	....
Ripe,.......................	19.64	7.70	6.81	.17	.65	.27
Overripe,..................	19.70	8.81	5.26	None	.48	.28

The chief point of interest in the above analysis is the gradual decline of the starch. When the apple is overripe the starch is entirely gone. When the apple is ripe only a small part of the starch is found. In the green apple very large quantities of starch are found. The sugar increases as the starch diminishes. There is a little over 14 percent of sugar in the perfectly ripe apple but much less in the green. The acidity calculated as malic acid diminishes as maturity is approached. In general it may be said that in the ripening of an apple the starch is converted into sugar and the acidity is diminished.

The composition of apples varies very greatly, as may be easily understood, with the variety of the apple examined, the character of the season in which it grew, and with the individual apple or sample. The best that can be done in showing the composition of apples is to give some of the most reliable analyses, covering the largest range of examinations in this and other countries. In the following table are given three sets of analyses of American apples and two sets of foreign apples, the first three being American and the second series being foreign.

The table gives the number of samples included in the analytical data, and the mean, maximum, and minimum results of the analyses.

	No. of Samples.	Total Solids.	Ash.	Acidity Expressed as H_2SO_4.	Protein N×6.25.	Reducing Sugar.	Cane Sugar.	Crude Fiber.
		Per-cent.	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*
Series 1:								
Average,		13.77	.240	.376	.590	7.04	4.59	....
Maximum,	13	16.47	.320	.670	.806	....	7.79	....
Minimum,		9.37	.170	.190	.356	....	1.80	....
Series 2:								
Average,		16.43	.27	.486	....	7.92	3.99	....
Maximum,	27	23.36	.34	.811	....	11.75	6.81	....
Minimum,		13.46	.17	.073	....	5.34	1.74	....
Series 3:								
Average,		13.65	.288	.452	.694	8.73	1.53	0.96
Maximum,	23	16.55	.404	.863	1.094	10.80	2.81	1.29
Minimum,		10.60	.228	.139	.421	6.89	.15	.70
Foreign Variety.								
Series 1:	17	16.42	.310	.614	.39	7.73	....	1.98
Series 2:								
Average,		15.07	.290	.234	....	10.12	.55	....
Maximum,	5	16.03	.360	.329	....	10.69	1.11	....
Minimum,		14.04	.240	.190	....	9.77	None	....

The combination of the average data of the American series shows a mean percentage of reducing or invert sugar of 7.90 and of cane sugar of 3.40. The average American apple therefore contains 11.30 percent sugar.

Dietetic Value.—The wholesomeness of apples is well recognized by all authors on physiology and hygiene, and the necessity of at least a partial fruit diet is acknowledged by all. Inasmuch as the apple is one of the most abundant of fruits, being produced in enormous quantities and sold often at a very low rate, its value as a food product is probably not as fully acknowledged by our own people as it should be. Through a greater part of the year apples can be made a staple article of diet. They are, of course, to be most highly recommended uncooked, and especially those varieties which have high palatable qualities and a suitable softness of texture. Very hard apples, even if palatable, are not recommended for eating raw. In a cooked state the apples are scarcely less wholesome and nutritious than in the raw state. It is true that in pastry their good qualities are often counteracted by the poor quality of the pastry envelop which, by reason of the method of its preparation, usually with an excessive quantity of lard or some other oil or fat, is rendered sometimes not only unpalatable but also difficult of digestion. In a stewed condition or prepared in some other unobjectionable manner no adverse criticism can be made upon the quality of the apple as an edible product. It may also be preserved in cans by sterilization by the process described under canned fruits. In this condition the product is known as "canned apples." When prepared in this way the apples are often flavored with sugar and sometimes with spices.

Many suggestions are often given as to the proper time for eating apples, but it probably makes little difference, so far as their dietary or hygienic character is concerned, whether they are eaten before or after meals or during meals. Since it is advisable, as a rule, not to introduce into the stomach continually fresh portions of food, it may be regarded as safe advice to suggest that the consumption of fruit be made practically a function of the meal and that it be not used indiscriminately, loading the stomach between meals with additional quantities of material which require digestion.

Length of Harvest.—By selecting varieties that mature early in the summer, in the early autumn, and in the late autumn the period for harvesting apples may be prolonged in the northern states from August to November. During this period, if the different varieties are properly selected for the maturing time, the ripe apple can be offered to the markets fresh from the tree during the entire season. As a rule the later maturing varieties are more palatable, more aromatic, and more nutritious than those that mature early.

Pectose Content of Apples.—The juice of apples like the juice of many other fruits has the property of coagulating to a solid or semi-solid material on boiling to a proper consistence and allowing to stand. It is due, essentially, to the existence of pectin or pectose bodies as described in the introduction to the chapter on fruits. This is a body allied to the carbohydrates and must be regarded as one of the essential constituents of apples and as imparting to them a characteristic flavor and quality.

Picking and Care of Apples.—The greatest difficulty experienced in marketing apples is in the danger of bruising either at the time of picking or during transportation. The apple when removed from the tree still remains a living organism with all of its functional activities, except additional growth, continuing in full power. As a rule, at the time of picking the apple is not yet mature, and unless intended for immediate consumption the utmost care should be exercised that the skin be not broken or the flesh bruised. Wherever the flesh of the apple is bruised it lessens its vitality and decay soon begins. This is shown very conclusively in the studies in the Bureau of Chemistry, where it was found that the starch which is still present in apples at the time of picking is gradually converted into sugar during the storage of the apple, thus increasing the palatability of the fruit. In those parts of the flesh that have been bruised and the vitality impaired the starch remains unchanged during the process of ripening. By the careful picking of the fruit and wrapping in soft papers, so as to prevent bruising in transit, apples of the proper character can be transported long distances, even beyond the seas, and arrive in good condition. This is an especially important fact in the American market, because our foreign trade in fresh apples is very large and constantly growing. It is useless to attempt to send a bruised or decaying apple on a long journey, since it will arrive in a condition unfit for consumption and, further than this, the organisms which are active in decay are conveyed to the sound fruit, and thus a whole package may be infected from a single apple in bad condition.

Storage of Apples.—The apple is a crop which is capable of being stored through many months, especially in winter time, without any material deterioration. The subject of the storage of apples has been carefully studied in the Bureau of Chemistry and the Bureau of Plant Industry, and the following are some of the conclusions which have been reached:

Tannin Principle.—Apples, as is the case with other fruits, have a notable content of tannin in some form. This constituent of apples is also active in giving flavor and palatability to the product. It is not present in quantities which render the apple unusually bitter or styptic in its character. Inasmuch as tannin is practically a universal constituent of all vegetable substances it must not be neglected as a normal constituent of fruit, while some of the fruits, especially the grape, owe some of their chief characteristics as to flavor and palatability to their tannin content.

Preparation of Apples for Drying.—The apples usually are brought to the large factories in wagons or by railway and are pared and sliced by machinery. Where proper control is exercised all the imperfect, rotten, and infected apples are rejected, and are used either for cattle feeding or sometimes, unfortunately, in cider making. The sound apples, after they are pared and sliced, are placed in trays and passed to a sulfuring apparatus where they are exposed to the fumes of burning sulfur to prevent their becoming dark upon evaporation. In other words it is essentially a bleaching process. The fumes of sulfur are also strongly antiseptic in character, and thus the finished product is less likely to decay or become infected with mould than a similar product not exposed to the fumes of sulfur. This process is extensively practiced, but its extent does not render it immune from proper criticism. Of 24 samples of evaporated fruits purchased on the open market 13 samples had been treated with sulfur fumes. This shows that over 50 percent of evaporated fruits are sulfured during the process of preparation and evaporation. The greater number of physiological and hygienic experts agree that the fumes of burning sulfur, commonly known as sulfurous acid, are injurious to health. It has been shown by researches in the Bureau of Chemistry that sulfurous acid or sulfites have a specific influence upon the red corpuscles of the blood, tending to diminish them very largely in relative numbers. This acid has also many other influences upon metabolism of an objectionable character. The question is one worthy of very careful consideration—whether for the sake of preserving a light color and securing immunity from mould or decay it is advisable to introduce into a food product any quantity whatever of a substance injurious to health. The answer to this question seems almost unavoidable, and it is, and should be, negative. It is highly advisable that the manufacturer of evaporated apples, as well as other fruits treated in a similar manner, should at once begin a series of experimental determinations for the purpose of ascertaining whether or not a product equally as palatable and more wholesome cannot be made without the use of sulfurous acid. The result of this investigation cannot be doubted. There is no doubt whatever, even at the present time, that by the elimination of the sulfuring process a product can be made which is far more wholesome, although perhaps not so presentable as that which is now made. If all manufacturers of evaporated fruits practice the same method there can be no financial injury as a result of the darker color which the finished product would assume. On the contrary the consumer of this product would soon understand that a different color was due to a more hygienic method of preparation, and hence the product would be commended in such a way as doubtless would largely increase its consumption. Instead of the manufacturer being injured by the prohibition of the use of sulfur he would in a very short time be greatly benefited. It is hoped that by the means of general information which is spread abroad concerning matters of this kind among our people and also through the operations of national and state laws the use of injurious substances, such as the fumes of burning sulfur, in connection with food products, may be entirely discontinued.

Dried Apples.—A very important industry in this country is the preservation of apples by drying or evaporation. The term "dried" apples is usually applied to the product which is naturally dried by cutting the apples into convenient sizes and exposing them to the action of the sun. This is more of a domestic than a commercial industry, and until the introduction of artificial drying was practiced very generally by the farmers' wives of the country. It was not an unusual thing in the autumn to see the roofs of smoke houses or kitchens practically covered with sliced apples exposed to the drying influence of the autumnal sun. In such cases care must be exercised always to have the exposed articles under such control as to enable them to be gathered up and put away when rain is threatening. The dried apple is a wholesome fruit, although somewhat unattractive in appearance owing to the darkening of the surface during the long exposure necessary to secure the proper degree of evaporation. When properly prepared the dried apple has its moisture content reduced to approximately 30 percent or less.

Evaporated Apples.—The term "evaporated" is applied to apples produced on the same principle as those "dried," but instead of being exposed to the sun's heat they are artificially dried by evaporation. This industry has reached a great magnitude in this country, and Wayne Co., New York, especially, may be regarded as one of the centers of the evaporating industry.

Cherries.—The cultivated cherry tree is believed by Bailey and Powell to have been derived from its ancestral type, the sour cherry (*Prunus cerasus* L.), which is characterized by a diffuse and mostly low, round-headed growth with fruit which is always red, with soft flesh and very sour taste, and from the sweet cherry (*Prunus avium* L.), a tall growing tree with the bark tending to peel off in birch-like rings and with variously colored fruit, spherical or heart-shaped, with the flesh hard or soft and generally sweet. There are a great many varieties of these trees. The cherry orchard begins to bear profitably at about the age of five years; the trees often live to a great age and continue to bear fruit. Records of cherry trees over a hundred years old are known. However, it is believed that about thirty years is the limit for profitable bearing. Cherries grow in all parts of the United States. Formerly the crop was a very important one in the East, especially New York, but of late years the California cherries have been more and more occupying the market. As a rule the California cherries are finer in appearance, larger, and freer from worms and imperfections, and possess a flavor which is often equal to that of the best flavored cherries grown in the East.

Composition of Cherries.—What has been said respecting the variations in the composition of apples is applicable with equal force to cherries. In the following table is given first the mean composition of six samples of cherries of American origin with the maximum and minimum. Following this is the mean composition of nine samples of foreign cherries.

Origin.	No. of Samples.	Total Solids.	Ash.	Acidity Expressed as H_2SO_4.	Protein $N \times 6.25$.	Total Sugars.
		Per-cent.	Per-cent.	Per-cent.	Per-cent.	Per-cent.
American						
Average		20.13	.443	.432	1.425	11.10
Maximum	6	38.84	.521	.605	1.727	12.75
Minimum		11.46	.403	.328	1.100	8.98
Foreign						
Average	9	19.74	.73	.665	.620	10.24

The data show that the average quantity of insoluble matter in cherries is about the same whether of American or foreign origin. The total solids represent that part of the cherry which is not water, including principally the cellulose, the ash, and the protein. The quantity of protein, as is seen, is quite small, the average being a little less than 1½ percent. The total sugar present, including cane sugar and reducing sugar, is a little over 11 percent. The analytical table does not give the minute portions of essential oils, ethereal substances, and acids to which the juice owes its distinctive flavor.

Varieties.—There are a great many trade-names given to different varieties of cherries. In New York the common varieties are the Black Tartarian, Black Eagle, Napoleon, Yellow Spanish, Windsor, May Duke, Robert's Red Heart, Governor Wood, Early Richmond, etc.

A great many cherry trees are also grown in Iowa. The varieties most prized in Iowa are the Malaheb, the Mazzard, Wild Bird Cherry, Sand Cherry, American Morello, Russian Seedling, Northwest, Duchess d'Angouleme, and very many others.

In Virginia the principal varieties, in addition to those mentioned, which are cultivated, are the Coe, Early Purple, Kirtland Mary, Rockport, Olivet, Philippe, etc.

The cherry owes one of its chief values to the fact that it is one of the first orchard fruits to ripen. In the vicinity of Washington cherries ripen in May, and further north not later than June. The cherry, therefore, offers a delicious and wholesome fruit early in the season, and is the precursor of the crops of orchard fruits which begin early in May and last until the frosts of autumn. It is eaten raw, stewed, or in the form of pie or pudding. For cooking purposes it is desirable that the pit of the cherry be removed.

Grapes.—There is no fruit more highly esteemed in this and other countries than grapes. The utilization of grapes for wine making is reserved for discussion in the companion volume to the present manual devoted to beverages. Table grapes are grown extensively in this country in New York, Ohio, Virginia, Missouri, and California. In fact, such grapes are grown in almost every state, but those mentioned embrace the principal grape-growing districts. The Catawba and Delaware varieties are the chief products of the northern vineyards. Many other varieties are produced in California, such as the Tokay, Muscat, and Malaga, while in the South one of the principal varieties is the Scuppernong. The oldest grape vine known in the United States is the original Scuppernong stock.

I am indebted to Dr. B. W. Kilgore, of Raleigh, N. C., for the following description of the vine and also for Fig. 48.

"The Scuppernong Vine on Roanoke Island, North Carolina.

"The old scuppernong grape vine on Roanoke Island is probably the oldest fruiting plant in America—certainly one of the oldest of which there is definite knowledge. A clear record of it begins in 1797, when the land on which it was growing was purchased by Maurice Baum. Previous to his purchase nothing definite is known as to its age or to whom it belonged, save the fact that it was then a very old vine, as Maurice Baum was told by his father that he had eaten grapes from it when a boy. From Maurice Baum the estate, of which the vine was a part, descended to his daughter, Mahala, and from her to Benjamin F. Meekins, her son, who is the present owner.

"The vine is situated on the northern end and on the eastern shore of the island, about two miles south of the supposed site of Fort Raleigh. It covers an area of about one-fourth of an acre, and as far back as can be remembered its growth has been stationary, probably due to a lack of proper training and inducement to spread. The vine has five large trunks averaging two feet in circumference which are indescribably gnarled and twisted. It is still vigorous

FIG. 48.—SCUPPERNONG GRAPE VINE, ROANOKE ISLAND.—(*Courtesy B. W. Kilgore.*)

and yields abundantly, seemingly unaffected by age in this respect. A conservative estimate of its yield is an average of sixty bushels of grapes a season."

There is no part of the country, however, that grows grapes so abundantly as California. Many thousands of acres are covered with vines, both for table use and wine making. The climate is remarkably well suited to produce a grape very rich in sugar. The edible grapes do not have so high a content of sugar as those used for wine making, as is shown by the data below.

Composition of California Grapes (three samples) (edible portion):

Water,	80.12	percent
Protein,	1.26	"
Sugar,	16.50	"
Pure ash,	0.50	"
Fat, fiber, etc.,	1.62	"

The preceding analyses are evidently of grapes for table use. The juice of the wine-making grapes of California, according to the composition of the wine, contains about 24 percent of sugars.

The luxurious growth of the vine in California is illustrated by Fig. 49, showing a scene in a vineyard near Fresno, California.

Peaches.—One of the most valued orchard fruits in the United States is the peach. The peach is a tree which is particularly sensitive to the environment in respect of bearing a crop. In many localities where

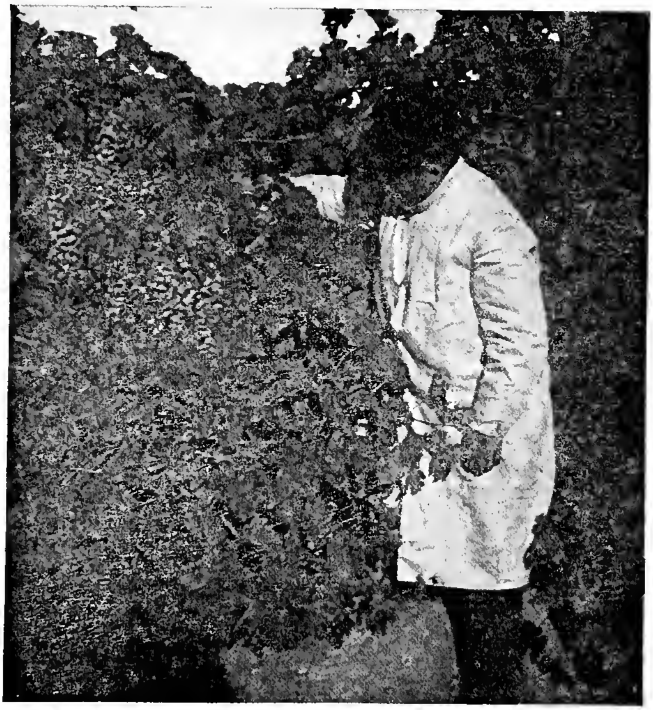


FIG. 49.—VINEYARD NEAR FRESNO, CALIFORNIA.—(*Photograph by H. W. Wiley.*)

peaches have once been valuable they have ceased to produce with any regularity, which renders the planting of an orchard inadvisable. The principal danger in the peach tree is the too early blooming and the exposure of the tender fruit to late frosts. The peach tree is also subject to many forms of disease, one of which, namely, the yellows, has baffled up to the present time the efforts of the experts to diagnose and treat. In planting a peach orchard experience has shown that it is well to plant the trees upon high ground or upon the sides of hills. By being placed on high ground near deep ravines it has been found that the chilling of the air, which would naturally come with frosts, makes the air heavier, so that it rolls down into the valleys, replacing the air on the hills with fresh portions unchilled and thus protecting the high ground from frost while the low ground is chilled below the freezing point. Everyone must have noticed, especially in the autumn at the time of the first frosts, that the vegetation in low lying land is usually killed before that on the adjacent hills. The peculiar susceptibility of the peach tree to the environment mentioned above has practically confined the culture of peaches to certain definite localities, as for instance to Michigan, Connecticut, Delaware, Maryland, Tennessee, and Georgia. The danger of late frosts of course does not attach to the peach tree grown in California and similarly situated localities. At the present time Georgia is probably the most important peach-growing state in the Union, both on account of the reasonable certainly of the crop and also because of the early date at which the peach can reach the markets of the large cities of the east and central portions of our country.

Many attempts have been made to protect the peach tree against the danger of premature blossoming and consequent exposure to the late frosts. In the cultivation of the trees it has been desirable to secure a variety which blooms as late in the spring as possible. The building of fires around a peach orchard in the spring when a frost is imminent has sometimes protected the orchard from disaster. This process is known as smudging. Another method of protecting the trees from the danger of late frosts is by whitewashing. The colors which absorb heat most readily are black and purple. White is one of the best protections by reason of its reflective power. A whitewashing of the branches of the trees and in fact of all the tree has been practiced with some success as retarding the early bloom of the buds. Elaborate studies of this method of treatment have been carried on by the Missouri station, and it has been developed that there is a considerable difference between the temperature of whitewashed and unwhitewashed peach twigs. The whitewash is therefore recommended as a means of retarding the development of the buds. The whitewashed trees bloom from a week to ten days later than those which are not thus treated. It is reasonably certain that by means of this kind or by cultivation a peach tree may be produced in any given locality which will put forth its buds from a week to ten days later than the normal period of blooming in that neighborhood. In regions where the winters are severe, the development of the tree in the early spring may also be prevented by placing straw round about it when the ground is frozen. The straw protects the frozen ground from rapid thawing and thus delays the development of the buds. The varieties of peach trees are legion, and it is useless to try to name them here. Some of the varieties most prized in Georgia are the Bishop, Champion, Crawford's Early, Chinese Free, Crimson Beauty, Crosby, etc.

Composition of the Peach.—Naturally, the peach varies greatly in its composition according to the variety, environment, and general accidental conditions. Its chief characteristics, of course, are the acid which it contains, its sugar content, and the taste and aroma due to the essential oils, ethers, etc., which are developed with proper delicacy in the fruit. The peach also has a distinct flavor associated with small quantities of hydrocyanic acid. This poisonous compound is developed in considerable quantities in the kernel of the fruit, and there are sufficient traces of the flavor above mentioned in the fruit itself to give a distinct and characteristic taste. The mean composition of some of the different varieties of peaches is given below:

Water,	88.1	percent
Protein,	.7	"
Fat,	.1	"
Ash,	.7	"
Sugar and other carbohydrates,	10.8	"

Free and Cling Peach.—Peaches may be divided into two great classes in respect of persistence with which the flesh adheres to the pit of the fruit. Peaches in which the flesh is separated easily from the pit, leaving the external surface of the pit dry and clean, are called freestones, while in the other variety, where the flesh is firmly attached to the pit and on the removal of the flesh a portion adheres thereto, the term "clingstone" is applied. There is probably no difference in the value of the two varieties, but by reason of the ease with which the freestone peach can be utilized for eating and cooking purposes it is sometimes preferred.

Since the development of rapid means of transportation and the effective applications of cold storage the peach is found in city markets from early spring to late autumn. The peaches in Florida are ready for the market in May and in Georgia from June on, while in the north the peach ripens at later periods up to October. In fact in the north the late peaches are esteemed as better in flavor and quality, and especially suitable for canning and preserving purposes.

Uses of the Peach.—Peaches are perhaps the most esteemed of all the common fruits for eating purposes. On the table the sliced peaches with sugar and cream is a common dish through the whole summer in almost every part of the country. Peach cobbler (a deep pie) and peach pudding are dishes which are highly esteemed.

Plums.—(Native Plums.) The following data represent the mean composition of three samples of California plums:

Total solids,	21.60	percent
Ash,	.52	"
Acidity,	1.00	"
Protein,	.40	"
Total sugars,	13.25	"

The plums imported from Japan and the hybrids produced therefrom are considered of higher value than the native plum. The Japan plum (*Prunus triflora*) has been introduced into this country for many years. They are larger and handsomer and have better shipping qualities than those of native origin, except perhaps in a few cases. The trees are also less subject to that great enemy of the plum, the curculio, than the native plum. Of the plum trees grown in Georgia the varieties of native trees which are recommended are the Clifford and the Wilder, of Japan trees the Lutts, Red June, Abundance, and Chabot, and of the hybrid varieties, the Wickson. Plums in Georgia mature from the first of June until the middle of July. Further north the date of maturity is later. The plum, as well as the cherry, flourishes especially in California, which is more famous for these fruits than any other state.

Quince.—The quince is a fruit which is not very extensively used raw, but is valued chiefly as a preserve. The quince flourishes in localities that produce good apples, but the magnitude of the crop is very restricted as compared with apples.

Small Fruits.

Blackberries (*Rubus nigrobaccus* var. *Sativus* Bailey).—Among the small fruits one of the most common and abundant is the blackberry. This fruit grows wild over large areas in the United States, mostly in the middle portion between the extreme north and south. The brier on which it grows is an annual plant, springing each year from the roots and dying after bearing fruit. The plant is very largely cultivated, bearing larger and more presentable berries, but gaining nothing in flavor and palatability. The berries are generally black when fully ripe, though red during the ripening stage and sometimes when mature. They are eaten raw, stewed, and in pies or "cobblers." The berry is extensively used for making jams, jellies, and preserves, and for canning purposes. The juice of the berry is used for making a wine, usually with the admixture of sugar. Blackberry cordial is blackberry juice preserved in whisky or brandy with sugar and aromatics.

Dewberry.—This is a variety of blackberry in which the vines lie on the ground instead of standing upright. Some of the dewberries possess unusual fragrance and palatability. In other respects they conform to the statements relating to blackberries.

Gooseberry (*Ribes oxyacanthoides* L.).—The gooseberry resembles very closely the currant in its general properties. The surface of the European gooseberry is covered with prickles, but the American variety is smooth. The gooseberry bush is found in most gardens, affording a fruit of high condimental value. The fruit is eaten raw, but is used principally in pies and as preserves.

Huckleberry (*Gaylussacia resinosa* Torr. and Gray).—The fruit of the huckleberry bush is used very extensively for making pies, especially in the northeastern parts of the United States. There are many varieties of the berry on the markets. The blueberry is one variety that is very abundant. The term whortleberry is also applied to this fruit.

Mulberry (*Morus nigra*).—The mulberry grows wild over extensive areas in the United States, especially in the Ohio valley. It is a tree valued highly for its wood, which is lasting and excellent for fence-posts. The berries ripen early in the summer or late in the spring and are used as food to a limited extent.

Raspberry (*Rubus strigosus* Michx.).—The raspberry resembles the blackberry in many of its characteristics. It is chiefly a cultivated plant, being less hardy than the blackberry, and therefore not growing wild to such an extent. The fruit matures just before the blackberry, and is usually of a red color and of a pleasant characteristic taste.

Strawberry (*Fragaria Chiloensis* Ehrh.).—For edible purposes in its fresh state the strawberry is the most important of the small fruits. It is offered on the markets at all seasons of the year—ripening in the winter time in Florida and California and coming into the markets in the late summer in the northern and northeastern states. It grows on vines lying on the ground and ripens early in the spring in the latitude of Washington, viz., from about the middle of May. It is eaten raw—often with sugar and cream—more extensively than any other small fruit. The wild strawberry is not so large as the cultivated variety, but is more highly prized for its aroma and taste.

Composition of Small Fruits.—

	Water.	Protein.	Fat.	Sugar, Starch Etc.	Ash.
	Percent.	Percent.	Percent.	Percent.	Percent.
Blackberries	86.3	1.3	1.0	10.9	0.5
Cranberries	88.9	0.4	0.6	9.9	0.2
Huckleberries	81.9	0.6	0.6	16.6	0.3
Raspberries	84.1	1.7	1.0	12.6	0.6
Strawberries	85.9	0.9	0.6	7.0	0.6

Tropical and Subtropical Fruits.

(Bulletin 87, Bureau of Chemistry.)

Anona.—This is a variety of edible fruit grown in the tropics, especially in Cuba, but on account of its restricted production is of little importance. There are three varieties, known as follows: Sweet-sop (anona) (*Anona squamosa* L.), sour-sop (guanabana) (*Anona muricata* L.), and custard apple (chirimoya) (*Anona reticulata* L.). The sour-sop is a green, irregular-shaped, pod-like fruit, varying from 3½ inches to 12 inches in length and about two-thirds as broad near the top, and curving to a blunt point at the lower end. The skin is thick and covered with numerous small, hooked briers. The pulp has the appearance of wet cotton and surrounds the numerous seed sacs containing the small brown seeds. A fibrous core runs through the fruit from the stem to the lower point. The fruit weighs from 3.5 ounces to 2.2 pounds.

The flavor is acid, but not too much so. This fruit is more extensively used in the manufacture of cooling beverages than directly as a food, but it is also used very extensively for making preserves. The sweet-sop resembles the sour-sop in general character, but does not attain by any means to so large a size. The fruit is heart-shaped and deeply creased. The pulp contains more sugar and less acid than that of the sour-sop. This variety is eaten fresh and is also used for flavoring beverages, but is not extensively used for making preserves. The third variety, known as the custard apple, varies in color from light green to reddish brown, and is shaped something like a strawberry. It has a thick skin and black seeds, and a pulp very similar to that of sweet-sop in flavor. It is eaten chiefly raw, and is not very extensively used in the manufacture of preserves.

Composition of the Sour- and Sweet-sop Varieties.—

Anona.	Edible Portion.	Solids.	Total Sugar.	Protein.	Ash.	Acidity.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Sour-sop,	72.30	19.03	13.07	1.65	.41	.51
Sweet-sop,	30.00	28.10	10.07	2.13	.92	.20

The above analyses show that the anona is a fruit which has about half the nutritive value of the banana. It has a much larger percentage of waste, especially the sweet-sop variety, nearly three-fourths of which is not edible.

Anona Preserves.—The anona preserves should be made exclusively with sugar and thus have the character of the fruit modified only by the amount of sugar added. In one sample of preserves analyzed the following data were obtained:

Total solids,	54.33	percent
Total sugar,	49.66	"
Protein,	.73	"
Ash,	.43	"
Acidity,	.19	"

The above data show that the natural constituents of the fruit have been diminished in quantity in proportion to the amount of sugar added.

The Avocado (*Persea persea*).—The avocado is a fruit which has only lately been introduced into the United States. Its common name is alligator pear and it is already very highly prized.

The cultivation of the alligator pear was first undertaken as a novelty, and its real value as a dessert fruit is only beginning to be appreciated. It is evident that this fruit will have a great vogue in the near future, and will be in great demand as soon as its production is on a scale which makes it accessible to the people of ordinary means. The edible part of the fruit is a sweet, soft substance with an agreeable taste and of a semi-solid consistence. It has a nutty and peculiar flavor which is very pleasing. In the regions where the alligator pear is grown it is often used in the raw state or after having been treated with a little salt. It is also often cut into small pieces and put into soup and is said to give a most agreeable odor and flavor thereto. The ripe fruit has different colors; it may be green, yellow, brown or dark purple or a combination of any of these colors. The alligator pear is particularly valued as a salad fruit.

Composition of the Avocado.—

Water,	81.10	per cent.
Protein,	1.00	"
Fat,	10.20	"
Starch and sugar,	6.80	"
Ash,	.90	"

These data show that the alligator pear is not a fruit which is very highly nutritious. Its chief nutrient is fat, the next most important elements being starch and sugar, but it is extremely deficient in protein, and, therefore, could not be regarded as a balanced ration. Its principal value, therefore, is based on its condimental properties rather than on its nutrients. Bulletins 61 and 77 of the Bureau of Plant Industry, Department of Agriculture, contain interesting information regarding the avocado. The accompanying illustration is taken from the latter report.

From the amount of fat in the alligator pear it might be regarded as a nut instead of a fruit, but its paucity of nitrogenous constituents excludes it from that category.

Bananas (*Musa*).—One of the most abundant and most important of the tropical fruits, for food purposes, is the banana. This fruit is not grown to any extent for food purposes in the United States, though it is produced on a limited scale in southern Florida. Immense quantities of bananas come into this country from the Central American states, particularly from Guatemala and Nicaragua. This fruit can be landed at New Orleans at very small expense for transportation, and for this reason can be distributed all over the country at a price which seems to be ridiculously small when it is considered that the fruit comes from so great a distance. It is also sent in large quantities to other ports, notably New York, Boston, and Baltimore. For shipping purposes the banana is gathered while still green, and often the ripening has not reached the stage at which the ordinary yellow color which characterizes the ripe fruit is seen when it reaches the markets in the center of the country. The banana is not only valued for its peculiar flavor, which is pleasant and sweet, sometimes almost too much so, but it also has a high nutritive value, being a substance rich in carbohydrates and growing in such

FIG. 50.—AVOCADO TREE.—(*Courtesy Department of Agriculture.*)

abundance that its price is within the reach of the poorest classes. Great quantities of bananas are also grown in Cuba, but they are mostly consumed by the native population, forming one of the principal foods of the island.

The banana has perhaps less waste than almost any other fruit, as the whole of the inner portion is edible. In the green fruit there is a large proportion of starch, which gradually changes into invert sugar in the ripe fruit. In thoroughly mature bananas the quantity of sugar is relatively high and the quantity of starch correspondingly low. Bananas are not only eaten raw but also fried and in various other forms. The banana is a fruit which, when properly cared for, can be transported over long distances and kept for a long time. When properly prepared the banana forms a nutritious diet, probably equal in value to the same amount of solid matter contained in the common fresh fruits. One hundred grams may be taken as the average weight of the banana, although some of them are very much larger. About 70 percent of the banana is edible and 30 percent inedible, that is, the skin, which while not wholly inedible is usually rejected. The banana is essentially a carbohydrate food, the percentage of protein not usually rising above 1.3. Nearly all the carbohydrates in the ripe fruit consist of sugars which are present both as reducing and as cane sugars. The average total percentage of sugar present in the banana is a little over 20.

The composition of the banana is shown in the following table which contains the data of analyses of two samples bought in the open market in Washington.

	Edible Portion.	Solids.	Total Sugars.	Protein.	Ash.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Sample 1,	62.10	26.13	21.71	1.13	.84
Sample 2,	64.50	26.24	21.76	1.21	.86

The analytical data were obtained upon the edible portion and not upon the whole fruit.

The bananas which are imported from Jamaica and Central America are represented by the analyses given above. They are commonly known as the Johnson banana. Smaller fruits with better flavors are grown in Cuba,—some of them are of a red color like the oronoco and colorado. The indiano is a large, yellow, angular fruit with a salmon-colored pulp and a rather disagreeable acid flavor.

With reference to the banana as a food product it is seen that, including the starch and digestible cellulose, it consists of at least 25 percent, in its edible portion, of carbohydrates suitable for food purposes. Its low content of protein indicates that it is not a well balanced ration, but should be eaten in connection with beans, peas, or other vegetables rich in protein, or with lean meat in order to secure a proper quantity of protein in the diet.

On account of the great abundance of the product and luxuriance of growth in the Central American states, it is evident that the banana might become a profitable source of industrial alcohol in that locality.

Cashew (Maranon) (*Anacardium occidentale*).—The cashew, of which the principal habitat is Cuba, is a small, oddly shaped, yellow and red fruit from two to three inches long and from ½ to two inches in diameter at the bottom, decreasing gradually in diameter toward the top. The seed is small and kidney-shaped and grows outside of the fruit at the lower end. The seed is regarded as poisonous until it has been roasted, due probably to the presence of hydrocyanic acid. After roasting it is regarded as a delectable edible. The meat of the seed of the cashew resembles the roasted chestnut, but contains more oil. The pulp is of a dull yellow color, is tough and very juicy, with an acid astringent flavor and a disagreeable odor. The fruit is not eaten raw but chiefly in preserves. The composition of the cashew is shown in the following table:

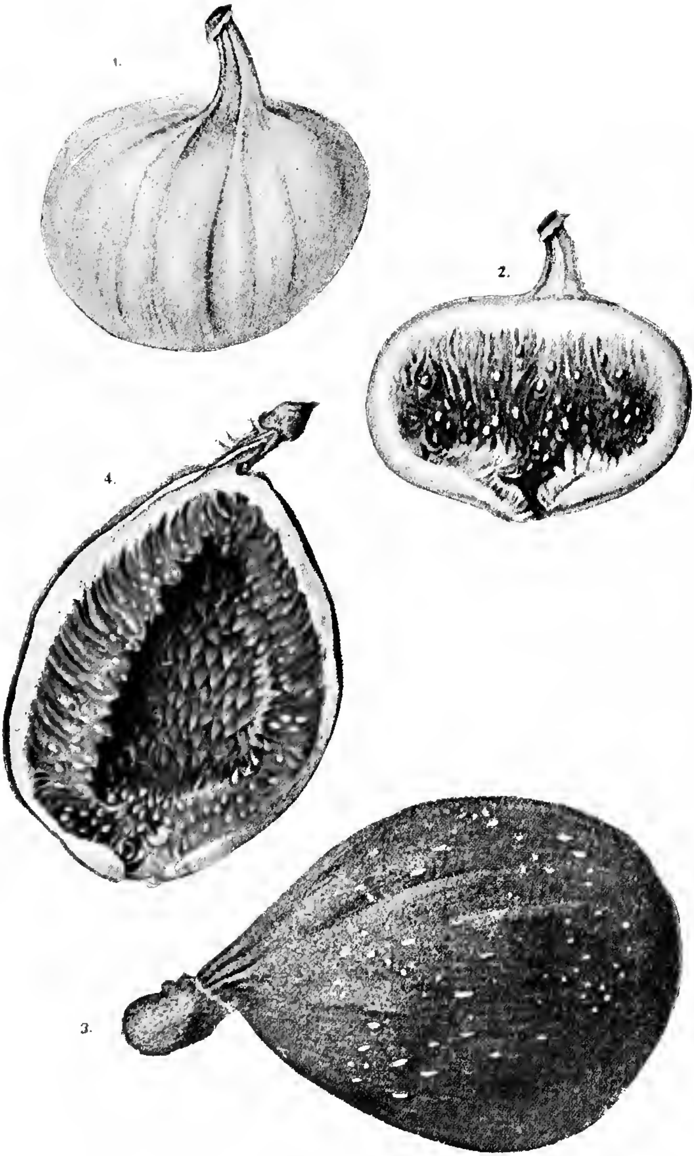
Composition of Edible Portion—85.9 percent.—

Solids,	12.84	percent
Sugar,	6.76	"
Acid,	.31	"
Ash,	.36	"

The composition is somewhat like that of the hicaco, but the cashew contains a larger proportion of acid and hence is better suited for preserves. The sample of cashew preserves examined had the following composition:

Solids,	71.22	percent
Sugar,	66.89	"
Protein,	.26	"
Acidity,	.08	"
Ash,	.14	"

Citrus Fruits.—The term "citrus fruit" is applied to that class of fruits represented by the orange, lemon, grape fruit, and lime. In the United States extensive areas are devoted to the production of citrus fruits, and it is claimed by connoisseurs that some of the best varieties grown anywhere in the world are the products of this country. Florida and southern California are two localities where the development of the citrus fruit industry has been carried to the greatest extent. The phenomenally cold winter which occurred in Florida some ten years ago almost ruined the citrus fruit industry in that state for the time being. In the reëstablishment of it the center of production has been extended farther south than it was before. It is believed that at the present time the industry has been extended sufficiently far south in the Florida peninsula to avoid any repetition of the great disaster which ruined the citrus groves in certain portions of the state at the time mentioned. The



DRYING FIGS

1. SMYRNA
2. SMYRNA SECTION
3. ADRIATIC
4. ADRIATIC SECTION

From Yearbook, U. S. Dept. of Agriculture, 1897

climate of southern California is more equable, and no injury has ever been experienced in that location from very low temperature. In Florida the oranges are cultivated without irrigation, while in southern California irrigation is universally practiced. The seasonal conditions are therefore under better control in California than in Florida.

Figs (*Ficus carica* L.).—The fig is a fruit which is well known in biblical and profane history. Together with the grape it is the fruit most often mentioned in the Bible.

The importance of the fig as a fruit and food is recognized in all the earlier writings, both sacred and profane. When dried and pressed into convenient forms it is a food which can be easily transported, and makes a ration well suited to supply heat and energy, although deficient in nitrogen in so far as a complete ration is concerned. The fig tree is extensively cultivated in all localities where the temperature permits its growth. Imported cured figs are often found badly infested with worms and their excreta, a condition which could be easily avoided with proper care.

The fig tree grows luxuriantly and to a great size in California, and the fruit, both fresh and dried, is of superior excellence. A typical illustration of a California fig tree is shown in Fig. 51.

The Smyrna fig has lately been introduced into the southern and western part of the United States with great success. It grows especially well in the southern part of California and Arizona. The Smyrna fig is one of the varieties which requires fertilization of the flower through the mediation of an insect. This process is called caprification. Although this variety of fig has only been introduced into California to any extent in the last five or six years, the growth of this most highly esteemed variety has so increased that at the present time the output of California alone amounts to about twelve million pounds per annum. The Smyrna and Adriatic figs, used largely for drying and preserving purposes, are seen in their natural colors in the appended colored plate.

Composition of Fresh Figs (Edible Portion).—

Water,	79.11	percent
Protein,	1.52	"
Sugar,	15.53	"
Pure ash,	.58	"
Fat, fiber, etc.,	3.26	"

Composition of Dried Figs.—

Water,	28.78	percent
Total sugar,	51.43	"
Acid as malic,	.71	"
Protein,	3.58	"
Ether extract,	1.27	"
Cellulose, etc.,	5.29	"
Crude fiber,	6.19	"
Ash,	2.75	"

The interesting process of caprification is thus described by Professor Hugh N. Starnes of the Georgia Experiment Station:

"In the base or false ovary of the gall flowers, which are merely degenerate pistillates, the egg of the *Blastophaga grossorum* or fig wasp—a minute insect—is deposited and develops to maturity. The wingless males emerge

FIG. 51.—FIG TREE THIRTY FEET HIGH NEAR YUBA, CALIFORNIA.—(*Photograph by H. W. Wiley.*)

first and, with their powerful mandibles, cut into the flowers containing the female wasps, partially release them, and impregnate them. The gravid females shortly complete the liberating process and, being winged, at once seek to escape for the instinctive purpose of laying their eggs. They emerge from the eye of the caprifig, after squeezing through the mass of pollen-covered anthers protecting the exit, and seek other fruit in which to lay their eggs.

Naturally they would enter the nearest caprifig in the proper stage of development. But, meanwhile, if the caprifig containing the colony has been plucked from its stem and suspended in the branches of an adjacent Smyrna tree, the female on emerging forces her way in a fruit of the latter class, losing her wings in the process, and at once begins a frantic scramble around the interior, searching for the anticipated gall flowers in which to deposit her eggs. Failing, necessarily, to find them, and incapable of again taking flight, she finally curls up and dies heartbroken, but not until she and her companions have between them pollinated every female flower in the cavity with the plentiful store of pollen conveyed from the caprifig—thereby insuring the development of the fruit."

Grape Fruit (Pomelo) (*Citrus decumana*).—The so-called grape fruit or pomelo is one of the largest products of the citrus family and also possesses properties which may be regarded as a cross between the lemon and the orange. It is more acid than the orange and sweeter than the lemon. This fruit is perhaps more highly esteemed than any other citrus variety for direct edible purposes, forming a breakfast dish which is eaten very extensively throughout all parts of the United States by those who are able to afford the luxury, for such it still is by reason of its high price. Large amounts of grape fruit are grown in the United States, though its culture is confined to the same localities as are the orange and lemon.

Composition of Grape Fruit (*Pomelo*).—The composition of the pomelo as given for the California product (Station Report, 1892, p. 256) shows this fruit to have the following composition:

Average weight,	357.00	grams
Rind,	23.50	percent
Seeds,	3.70	"
Edible portion,	72.80	"

Composition of the juice from the edible portion:

Total solids,	13.20	percent
Total sugars,	9.50	"
Acids (as citric),	2.70	"

Professor Colby says in discussing these analyses that the proportion of acid is larger in these samples than the general taste demands.

Cuban Grape Fruit.—The grape fruit which is grown in Cuba has quite a different character. Its flavor is mild, and it is almost devoid of the bitter taste which is found in the American product, and which adds greatly to its palatable properties when the consumer becomes accustomed to it.

A marmalade is made from the grape fruit similar in all respects, except the peculiar flavor given by the raw material, to that made from oranges. It is evident from its high palatable properties and its wholesomeness that grape fruit will become more and more an article of value and be consumed in large quantities throughout the country.

Guava (*Psidium Guajava*).—This fruit is grown very extensively in both California and Florida, also in Cuba, where a number of varieties grow wild. The white guava is a small, round fruit, grayish-white or yellow in color, and having an average weight of 1.5 ounces. The pear-shaped fruit, the guava of Peru, is about twice the size of the white variety, but otherwise resembles it very closely. Both varieties contain large numbers of small seeds scattered throughout the yellowish-white pulp. As a rule the guava is not eaten raw, but it is a fruit from which some of the most highly prized jelly pastes and preserves are made.

Composition of the Guava.—The guava contains, in its fresh state, an average of a little less than 80 percent of water and a little more than 20 percent of solid matter. The solid materials in guavas are quite insoluble in water, more than one-half of them not passing into solution. The chief part of the soluble constituents of guavas are the sugars, and these exist chiefly in the invert state. The total percentage of sugar in guavas in the fresh state averages about six, the protein amounts to about one percent, and the ash to a little over one-half of one percent. The guava, therefore, is condimental rather than nutritive, and for this reason it is not a valuable food product eaten in the raw state.

Guava Preserves.—A large number of preserves are made from the guava, and these products are well known and relished throughout the country. The preserves are in various forms, being chiefly pastes, marmalades, and jellies. These preparations contain the aromas and flavoring qualities of the fruit, and when pure contain no added product save sugar. They contain from 60 to 75 percent of added sugar. The preserved products of the guava are generally packed in wooden boxes, lined with paper, though some are packed in glass. The crystallized guava, the guava cream, and the pastes contain large quantities of added sugar, namely, about 80 percent. These preserves naturally have a very low acid content by reason of the quantity of sugar which has been added in their preparation. In this country often the whole fruits are preserved in sugar sirup.

Hicaco (*Chrysobalanus icaco*).—The fruit of the hicaco is small and round, varying from one to three inches in diameter. The average weight of each fruit is about ¼ oz. The skin is thin and green in color, shading to red on the side exposed to the sun. It grows on a small shrub and is sometimes called the cocoa plum. The surface is somewhat shrivelled and wrinkled, and the seed weighs almost half as much as the whole fruit. The fruit is not eaten in a fresh state, but is used for making preserves. It is sweet to the taste and has a low acid content. The composition of the fresh fruit is shown by the following table:

Composition of Edible Portion—68.9 percent.—

Total solids,	14.29	percent
Total sugar,	5.18	"
Protein,	.46	"
Acidity,	.10	"
Ash,	.96	"

These data show that the hicaco is a fruit low in nutritive value, in so far as sugar is concerned, low in protein and of a very slight acidity.

Hicaco Preserves.—A sample of hicaco preserves was found to have the following composition:

Total solids,	65.07	percent
Sugar,	60.08	"
Protein,	.12	"
Ash,	.14	"
Acidity,	.05	"

The above data indicate only the change in composition which would come from adding the sugar in the process of manufacture. By reason of the low acidity of the fruit the sugar in the preserves would, theoretically, be largely cane sugar. In the case mentioned, however, one-third of the sugar was inverted. Whether this was accomplished by the action of the acid on the sugar during the process of manufacture or by the use of molasses instead of sugar in the preserves does not appear. More likely it is due to the latter.

Kumquat (*Citrus japonica*).—The kumquat is one of the smallest of citrus fruits. It stands as one extreme of that important family of which the grape fruit or pomelo represents the other. The fruit is oval in shape, about one inch in diameter, and is one and one-half inches long. It may be regarded as a dwarf orange, and was brought into the United States from Japan, although it is a native of China. The name—kumquat—is of Chinese origin and is intended to mean "Gold Orange." The kumquat tree, under favorable circumstances, reaches a height of 10 or 12 feet and forms a compact, symmetrical, and handsome head. The pulp of the fruit is very tender and agreeably acid and the rind is spicy, as is the case with most of the acid fruits. It is not only valued as a fruit, but the tree is also highly prized as an ornament. Its beautifully colored fruit, in contrast with its green leaves, presents a most agreeable spectacle. It is grown in the United States principally in Florida. The composition of the kumquat is practically that of the orange.

Lemons.—The citrus fruit, next in importance to the orange, if not more important, is the lemon (*Citrus limonum*). This fruit is grown extensively in the United States in the same localities that produce the orange, that is, chiefly in Florida and southern California. Its method of cultivation, general treatment, time of ripening and harvesting are the same as that of the orange. Its principal difference from the orange is in its greater acidity and in certain peculiarities of its aromatic and oily substances. From the rind is produced an essential oil which, while resembling that of the orange in general character, has distinct properties which easily discriminate it from the orange product. The lemon also has a correspondingly less proportion of sugar than the orange. In 22 analyses of California lemons they were found to contain 5.26 percent of acid and only 2.33 percent of sugar. The distinct feature of the lemon, therefore, is its acidity. The principal acid present in lemons is citric acid, though other organic acids are also found. The acids are either free or in combination with a base, the principal base being potash On account of its high acidity and low sugar content the lemon is used more as a relish and in the manufacture of acid beverages than directly as a food. There are some varieties known as sweet lemons which are eaten as oranges or used directly for food purposes, but generally the lemon is too sour and acid for consumption in this manner.

Lime.—A species of citrus fruit which is even more acid than the lemon is known as the lime (*Citrus hysrix acida*).

Limes are not eaten directly as food on account of their high acidity, but their expressed juice is sold throughout the world for beverages and medicinal purposes. The lime also yields an essential oil, which is very similar in character to that derived from lemons. In fact the lime may be regarded as a very sour lemon, just as the orange may be regarded as a very sweet one.

Adulteration of Lime Juice.—Unfortunately lime juice is offered on the market often in entirely spurious forms, that is, a mixture made up with flavoring of an acid character resembling that of the natural juice. The natural juice is also frequently adulterated by the addition of preservatives. Among these, sulfurous and salicylic acids are perhaps the most frequent. Lime juice can be perfectly preserved by sterilization, and there is no necessity for the use of preservatives therein.

In the tropics there is also found a lime of a saccharine character known as the sweet lime, but this fruit does not have a very great vogue.

Mamey Colorado.—This is a tropical fruit which is very extensively grown in Cuba, and derives its local name from a very slight outward resemblance to the mammee (*Mammea americana*). These two fruits, however, have no botanical or other relation to each other, nor do they have any internal resemblance. The mamey colorado is chocolate brown in color, oval or round in shape, and its average weight is about 1.5 pounds. The skin is thick and coarse. The pulp has a yellowish color, varying to a deep scarlet, and is slightly fibrous and firm, but mealy and rather dry. It has a sweetish taste with very little acid flavor. It is eaten chiefly in the fresh state and is also stewed with sugar. The fruit usually contains but one seed, though as many as four are sometimes found. The seeds are imbedded in a soft core and are irregularly oval. The natural season is from December to August. These fruits are very largely used for making preserves.

The composition of the mamey colorado is as follows:

Composition of Edible Portion—86.10 percent.—

Solids,	34.01	percent
Total ash,	.80	"
Acid,	.10	"
Total sugar,	22.05	"

The analysis shows that the mamey colorado is a fruit which in its edible properties and nutritive value very closely resembles the banana.

Mamey de Santo Domingo (*Mammea americana*).—This is a fruit extensively used in Cuba and other tropical countries. It is of a light brown color, from three to ten inches in diameter, and weighs sometimes as much as 1½ pounds. The skin is thick and fibrous, the outer surface being tough and covered with small brown spots. The pulp is dark yellow in color, firm, and very juicy. It has a sweet characteristic flavor and a pleasant aromatic odor. The seeds sometimes measure three inches in diameter and cling tenaciously to the pulp. It is very commonly eaten raw and is highly esteemed for preserving purposes.

The composition of the mamey de Santo Domingo is shown in the following table:

Composition of Edible Portion—60.70 percent.—

Solids,	14.12	percent
Total ash,	.31	"
Acids,	.42	"
Protein,	.49	"
Total sugar,	9.47	"

The above data show that this fruit is very much less sweet and very much more acid than the mamey colorado and for nutritive purposes is of much less value, but by reason of its greater acidity and higher flavoring it is more suitable for the manufacture of preserves than the fruit resembling it in external appearances and name. It is used extensively in the manufacture of preserves and marmalades which are so similar in composition as not to be distinguished from each other by their chemical analyses.

The compositions of a preserve known as mamey en almibar and a marmalade known as mermelade de mamey are shown in the following table:

Substance.	Solids.	Total Ash.	Acids.	Protein.	Total Sugars.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Mamey en almibar,	60.05	.154	.194	.363	57.45
Mermelade de mamey,	69.74	.149	.123	.269	62.68

Mango (*Magnifera indica* L.).—The mango is a fruit which is highly prized throughout the world. It is a native of southern Asia, where it has been known from earliest times. In the United States the mango is

FIG. 52.—JAMAICA MANGO TREE.—(*By permission American Nut and Fruit Co.*)

chiefly grown in Florida as a horticultural crop. The mango is a tree peculiarly sensitive to frost, and therefore does not grow as far north as oranges.

Its profitable cultivation at present is confined to the extreme southern part of the Florida peninsula.

The mango is an evergreen tree. In Florida, under favorable conditions of growth, it reaches as high as 40 or 50 feet. It makes a tree of graceful appearance with a dense, dome-shaped top. The color of the mango fruit is varied; it may be red, green, or yellow, or a mixture of these colors. The tree and fruit both possess an agreeable odor, and every part of the tree, almost, can be of some economic value. The ripe fruit is a delicious dessert and is wholesome. It is often recommended for its medicinal properties. The rind and fiber, as well as the unripe fruit, are acid and full of tannin, which makes them astringent to the taste. Mangos may be eaten in the raw state, and they are also valued for making preserves, pickles, marmalades, and jelly. A very popular sauce known as mango chutney is prepared from the mango and is largely used in the United States and England, being mostly imported from India. The appearance of the tree is shown in Fig. 52.

Oranges (*Citrus aurantium*).—This fruit is characterized by its delightful flavor and by the distribution of certain aromatic oils, especially in the rind, which give it a peculiar aroma and taste. The orange has a thick yellow rind which, while edible, is not usually eaten, but is the source of valuable essential oils. A large part of the orange, as far as weight is concerned, is not usually eaten; usually from 25 to 40 percent of the weight is in the rind or some inedible portion. The ash of the orange is usually less than one-half of one percent. The predominant organic acid of the orange is citric, although other organic acids are present. The quantity of protein present in an orange is very small, usually not exceeding very much a half of one percent. The quantity of sugar varies greatly in different samples. It is present both as cane sugar or sucrose and as reducing or invert sugar. In the very sweet orange the quantity reaches as high as 10 percent or even greater, while in the sour orange it is less. The principal food value of the orange, as far as nutriment is concerned, is its sugar. The orange, however, has other valuable properties, especially from a hygienic standpoint, aside from its nutriment. The organic salts which it contains, the organic acids, and other condimental material make the orange an exceptionally wholesome fruit, exercising a beneficial effect upon the digestive process and especially aiding in the passage of the undigested food through the alimentary canal. The orange is a fruit which has lasting keeping qualities. It is not unusual to see ripe oranges which are edible hanging on the same tree with the blossoms which are blooming for the next year's crop. In California and Florida the oranges begin to ripen in November and may be continuously harvested until the following April, if it be advisable to leave them on the tree for that length of time. Owing to the thick and resistant skin of the orange, it can be kept for a long time without material deterioration after harvesting, if care be taken to avoid bruising or injuring the fruit in any way while handling. Oranges thus harvested and wrapped in paper and kept at a low temperature will keep for weeks and even months, and still be edible and nourishing. This property of the orange makes it possible to supply the markets of the world practically throughout the entire year with one of the most delicious and nutritious of fruits. In former years the orange was regarded as a luxury, but at the present time it is a staple article of diet even for people in moderate circumstances, and is often eaten by those who are poor. In Fig. 53 is given a typical illustration of a California orange grove.

The culture of the orange has demanded the highest agricultural and scientific skill, and perhaps there is no crop produced to which greater attention

FIG. 53.—AN EDGE OF A CALIFORNIA ORANGE GROVE.—(*Bureau of Plant Industry.*)

has been paid. In Florida, especially, the oranges are grown on soil which is not much more than poor sand, and hence the scientific feeding of the trees, that is, the fertilization of the soil in which they grow, is necessary to success. As a result of this application of science luxuriant crops of oranges are found growing upon sandy soil which without scientific treatment would be almost barren. The soils in southern California, on the other hand, are very rich in natural plant food, but this does not obviate the necessity of scientific manuring. Oranges grow throughout the year in tropical and semi-tropical regions. It is considered by connoisseurs, however, that the oranges grown in the semi-tropical regions, that is far enough north for a little frost to come during the winter, but without a sufficient degree of cold to injure the trees, are of better quality than those grown in tropical regions where frost is unknown.

The Seedless Orange.—The variety of orange which contains no seed has been widely cultivated in the United States, and by reason of the absence of seeds is more highly prized by many than the ordinary orange for edible

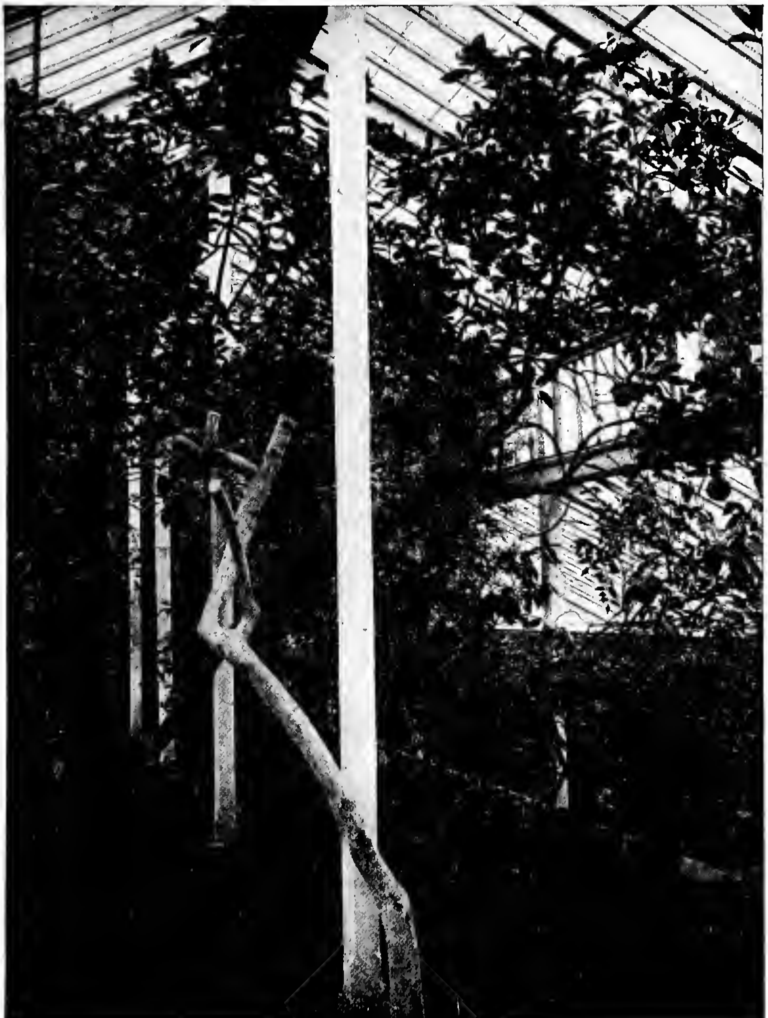


FIG. 54.—THE ORIGINAL SEEDLESS ORANGE TREE.—(*Courtesy Bureau of Plant Industry.*)

purposes. Since the orange tree has been cultivated by grafting rather than by direct production of the different varieties from the natural seed, it has been possible to secure a fruit without seeds. Whether such an unnatural product will continue to maintain its high rank as an edible product remains to be seen. The seedless orange tree, from which are descended the greater part of these trees in the United States, was secured by Mr. William Sanders from Bahia. Its present appearance in the greenhouse of the Department of Agriculture is shown in Fig. 54. The navel orange is exceedingly beautiful as it grows upon the tree. A bunch of these oranges growing on the parent tree in Washington is shown in Fig. 55.

FIG. 55.—A GROUP OF THE WASHINGTON NAVEL ORANGES ON THE TREE.—(*Courtesy Bureau of Plant Industry.*)

Pineapple.—The pineapple is a fruit grown very extensively in tropical and also subtropical countries. It is a crop of great importance in Florida. The flavor and aroma of the pineapple grown in subtropical countries is often preferred to that of the tropical grown fruit. Pineapples grow best when sheltered to some extent from the direct rays of the sun. In Florida it is planted near live oaks, where a partial shade is secured. It is often artificially covered by means of narrow boards placed near together and yet leaving abundant space for the sunlight. Sometimes these covered fields are two or three acres in extent. In Fig. 56 is given a representation of the pineapple growing under a covering of this kind in Florida at the Agricultural Experiment Station, Lake City.

Formerly pineapples were regarded as great luxuries, and often were set up in the center of the table as an ornament rather than as a dessert. They have now become very common and are frequently used as a dessert, for flavoring ice cream, for preserving, and for general use as a fruit.

Adulteration of Pineapples.—The only adulterations which are found in

FIG. 56.—COVERED PINEAPPLE.—(*Courtesy of Florida Experiment Station.*)

pineapples are of course in the canned product. Investigations in the Bureau of Chemistry show that adulteration is not extensively practiced, unless the addition of cane sugar without notice can be so regarded.

From the point of view of the collection of duties, the addition of cane sugar without notice is an adulteration, since under provision of law pineapples canned in their own juice pay one rate of duty and when preserved with sugar pay another. Inasmuch as the label of a food product should tell the whole truth concerning it, the addition of cane sugar, without notice to that effect upon the label, is calculated to deceive and should not be practiced. There is no objection of any kind to the use of cane sugar in the canning of pineapples if the label indicates that this has been done. On the other hand there is no reason why the addition of sugar should be practiced. The pineapples are bought and consumed for their natural flavor, and not on account of the added sugar which they may contain. In the canning of pineapples it is just as easy to secure complete sterilization in their own juice as it is to secure it with the added sirup. In practice, however, it is more convenient after filling the cans with the pieces of pines to add a sugar sirup to fill up the spaces than to secure sterilization by the application of heat alone, which would not cause a sufficient quantity of juice to exude to fill up the interstices of the cans, and they, therefore, would be partially empty.

Canned Pineapples.—There is a very large trade in this country in canned pineapples imported from Singapore and the Straits Settlements and the Bahamas. The pines are usually canned with the addition of sugar, and those that come to our ports are as a rule sweetened only with cane sugar.

A large number of analyses has been made of these canned pineapples in the Bureau of Chemistry and the general data which were secured are presented below:

Canned pineapples from Singapore, average, maximum, and minimum composition:

Data.	Solids.	Sugar.	Protein.	Ash.	Acidity.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Average,	20.15	17.90	.46	.28	.30
Maximum,	25.30	25.10	.60	.36	.43
Minimum,	18.18	14.87	.39	.21	.16

The above data show that it is possible to compute the average quantity of sugar which is added in the preparation of the sample. If we assume in round numbers that the natural pine contains 12 percent of sugar, we find that approximately eight pounds per hundred of fruit have been added in the preparation of the pines from Singapore.

Below is found the average, maximum, and minimum composition of ten samples of canned pineapples from the Straits Settlements:

Data.	Solids.	Sugar.	Protein.	Ash.	Acidity.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Average,	21.04	18.45	.47	.26	.26
Maximum,	24.28	21.94	.57	.32	.32
Minimum,	17.32	14.54	.39	.22	.17

These data show that the preparation of the pines in the Straits Settlements for shipment in cans is the same as that in Singapore. The average amount of sugar added appears to be about one percent greater.

Average composition of canned pineapples from the Bahamas:

Data.	Solids.	Sugar.	Protein.	Ash	Acidity.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Average,	13.78	10.69	.34	.38	.57
Maximum,	26.78	22.43	.46	.50	1.18
Minimum,	8.54	6.33	.20	.22	.22

The above data show that nearly all the canned pineapples coming from the Bahamas must be regarded as canned in their natural juice without the addition of sugar. Of the whole number of samples examined, only four gave any indication of containing added sugar.

Composition of the Pineapple.—The average composition of twenty-two samples of fresh pineapple grown in Florida, as determined in the Bureau of Chemistry, is as follows:

Total solids,	13.85	percent
Total sugar,	11.69	"
Protein,	.40	"
Ash,	.42	"
Acidity,	.52	"

Of the sugars 4.44 percent existed in the form of invert or reducing sugar and 6.88 percent as cane sugar. These data show that the nutritive value of a pineapple lies chiefly in the sugar which it contains. However, the ethereal and aromatic properties of the pineapple give to it its chief value as a food, since it is the flavor and aroma rather than the nutriment in the fruit which make it valued as a food. These flavors and aromas are due to essential oils and ethers or compound ethers, and they exist in such minute quantities as to escape ordinary chemical investigation. A study of the details of analyses shows that there is a wide variation in the percentage of sugar. In two instances the total sugar fell below eight percent, but those evidently were green and imperfect samples and were not included in the general average.

The highest quantity of sugar found in any Florida pineapple was 15.28 percent. The data show that in general it may be said that the Florida pineapple contains nearly 12 percent of its weight of sugar.

Average Composition of Cuban Pineapples.—The average composition of

10 samples of Cuban pineapples examined in the Bureau of Chemistry is shown in the following data:

Total solids,	14.52	percent
Sugars,	11.87	"
Protein,	.40	"
Ash,	.35	"
Acidity,	.56	"

These data show that the Cuban pineapple is only a trifle sweeter than that grown in Florida and has in general the same composition.

The Florida pineapples when placed on the market have qualities which are by most connoisseurs judged to be superior to those of Cuban origin, although these qualities are not indicated by any marked difference in the analytical results.

The average composition of Bahama pineapples, examined in the Bureau of Chemistry, is given in the following table:

Total solids,	14.81	percent
Sugar,	12.22	"
Protein,	.48	"
Ash,	.40	"
Acidity,	.77	"

The Bahama pineapple, as is seen by the above data, is somewhat sweeter than the Florida or Cuban grown fruit and also has a higher acidity.

Average Composition of Porto Rican Pineapples.—Two samples of Porto Rican pines, examined in the Bureau of Chemistry, had the following composition:

Total solids,	15.91	percent
Total sugar,	15.36	"
Protein,	.48	"
Ash,	.37	"
Acidity,	.72	"

The other samples of pines coming from Porto Rico were so immature that it was found they contained only about one-half the percentage of sugar and one-half the total solids of the ripened fruits. They were probably harvested in an immature state in order to withstand the vicissitudes of transportation. The above data show that the ripe pines of Porto Rico are even richer than those of the Bahamas in sugar and nutritive elements.

The average, maximum, and minimum data for all samples of the fresh pines from all countries, examined in the Bureau of Chemistry, show the following composition:

Data.	Solids.	Sugar.	Protein.	Ash.	Acidity.
	Percent.	Percent.	Percent.	Percent.	Percent.
Average,	14.17	11.90	.42	.40	.60
Maximum,	18.86	15.28	.57	.55	.85
Minimum,	10.78	8.20	.21	.27	.30

In order that some idea might be obtained of the composition of the pines grown at Singapore and Nassau, the consuls in those localities were requested to secure the preservation of the pines by sterilization without the addition of any substance, that is, their preservation in their natural juice. In this condition the fruit of the pine, naturally preserved, was sent to the Bureau of Chemistry and subjected to analysis with the following average results:

Average Composition (ten samples from Singapore).—

Solids,	13.39	percent
Sugars,	11.73	"
Protein,	.48	"
Ash,	.38	"
Acidity,	.39	"

Average Composition (two samples from Nassau).—

Solids,	13.18	percent
Sugars,	10.86	"
Protein,	.40	"
Ash,	.41	"
Acidity,	.58	"

The above data show that the pineapples grown in Singapore and Nassau are not notably different in composition from those grown in Florida, Cuba, and Jamaica. All the data indicate that the pineapples grown in different parts of the world have practically the same composition at the same state of maturity.

Sapota (Sapodilla) (*Sapota zapotilla* (Jacq.) Coville).—This is a tropical fruit which is grown in large quantities in Cuba, where two varieties are known, differing only in shape, one being round and the other oval. In the Havana markets the latter variety is incorrectly known as the nispero. This name, however, is properly applied to the fruit loquat (*Eriobotrya japonica*). The fruit is small, weighing usually under two ounces, has a brown or brownish-green color and in general appearance resembles a smooth, dark potato. The skin is thick and coarse in texture, the pulp is yellowish-brown in color, granular in texture, and rich in juice. The odor is characteristic, and the taste is quite sweet. The seeds number from one to five and are contained in a soft open core,—they are of a brownish-black color with a single white stripe, and measure from three-quarters to one inch in length. The fruit comes into use about the first of April and lasts until the end of summer. It is a very popular fruit in summer and deserves more attention in the various markets than it has yet received. The sap of the sapota tree and juice of the green fruit when concentrated furnish the material known as chicle, from which chewing-gum is made. The compositions of the round and long sapota and the natural preserved pulp of the sapota are given in the following table:

Composition of Edible Portion.—

Sample.	Edible Portion.	Composition of Edible Portion.				
		Solids.	Total ash.	Acids.	Protein.	Total sugar.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Round sapota,	76.40	23.07	0.384	0.132	0.350	10.85
Long sapota,	80.90	21.01	.555	.162	.650	12.76
Natural sapota preserves,	....	22.95	.399	.086	.231	11.30

The sapota is also used in the manufacture of preserves by boiling it with sugar in the usual way. The analyses show that the sapota is a fruit which is principally valuable as a carbohydrate food. It has, however, very little acid, and is a much sweeter fruit than the anona and, therefore, more pleasant to the taste.

Star-apple (Cainito) (*Chrysophyllum cainito*).—The star-apple is one of the less important fruits which abound in Cuba. It is not very extensively used, but medicinal properties are attributed to it. Three different varieties are sold in the Havana markets,—one of a white color and two purple. The first attains the size of a small apple, approaching about seven ounces in weight. There are two kinds of meat in the pulp; the outer portion is a white, gelatinous matter which contains the small black seed and is really the edible portion, and constitutes about one-third the weight of the fruit. The outer fibrous and purple portion of the flesh is inedible. The inner pulp has a sweet characteristic flavor and is eaten raw. No preserves were found made of this in Cuban markets. The composition of the white star-apple is shown in the following table:

Composition of Edible Portion —41.80 percent.—

Solids,	14.23	percent
Sugar,	7.91	"
Protein,	.67	"
Ash,	.35	"
Acidity,	.05	"

These data show that the fruit is not of a very high nutritive order, and on account of its low acidity it is not suitable for the making of preserves.

Tamarind (*Tamarindus Indica*).—This fruit belongs to the leguminous family and forms a dark brown pod from one to six inches in length and from three-fourths of an inch to one inch in width. The rind is thin and very brittle.

Within the pod is found a dark-colored pasty material, closely attached to the seed sacks and joined to the stem of the pod by coarse fibers. This pasty material constitutes the edible portion of the fruit and has a very sour taste which serves to mask the large amount of sugar, sometimes as much as 30 percent, which it contains. The tamarind is remarkable as having the highest content both of acid and sugar of any of the edible fruits which are in common use. It contains more acid, for instance, than the sourest lime and more sugar than the sweetest fruit. The tamarind is not very largely used directly for edible purposes but is a component of many refreshing summer beverages and is used for flavoring other products. It has mild purgative properties, and hence its intermittent use in small quantities tends to keep in proper regulation the mechanical movements which are so necessary to normal digestion.

Composition of the Tamarind.—

Water,	47.47	percent
Acid,	6.03	"
Sugar,	31.43	
Protein,	1.36	"
Ash,	1.56	"

The above data show that the tamarind is essentially of a carbohydrate nature, its chief food value being in the sugar which it contains. On account of its high acidity very little of the sugar which is present is in the form of sucrose or cane sugar, but is mostly in an invert condition.

Preparation of Tamarinds.—Tamarinds are also utilized quite extensively in the form of tamarind paste which is made up chiefly by the addition of cane sugar to the pulp; as much as 75 percent of sugar is often added in the making of this product. Another form of preparation is called tamarind pulp, which has practically the same composition as the paste. These two bodies may be called tamarind preserves. The proportion of pulp to added sugar is about as 20 to 80.

Mineral Constituents of Tropical Fruits.—The mineral content of the edible portions of fruits is important, both from a dietetic and chemical point of view.

The mineral substances in fruits not only add to their palatability but also have important functions in digestion and assimilation. The lime and phosphoric acid which the ash of fruits contain are foods that nourish certain tissues of the body, such as the bones. The other mineral ingredients of fruits take an active part in the circulation of the fluids of the body. Since the modern development of physiological chemistry, what is known as osmotic force, or the power that causes solutions to pass through membranes, is believed to be due largely to the mineral constituents of the juices of the body. These mineral constituents are therefore necessary in the food. The following table gives the total quantity of ash in the edible portion of the tropical fruits named, together with the composition of the ash in respect of its most important constituents (Bulletin 87, Bureau of Chemistry):

ANALYSES OF THE ASH OF THE EDIBLE PORTION OF THE SEVERAL FRUITS.

Description of Sample.	Total Ash.	Silica (SiO_2).	Potash (K_2O).	Lime (CaO).	Magnesia (MgO).	Ferric Oxid (Fe_2O_3)	Phosphoric Acid (P_2O_5).	Sulfuric Acid (SO_3).	Chlorin (Cl).
	Per-cent.	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*	*Per-cent.*
Orange (china),	0.52	1.01	40.66	10.26	5.27	1.09	8.56	2.84	2.44
Orange (rough skin),	.55	..	49.15	2.62	1.41	4.51	7.42	3.42	1.50
Orange (sour),	.57	..	45.09	7.95	2.17	2.40	8.70	2.72	.98
Grape fruit,	.39	..	44.19	7.34	3.92	1.28	11.09	3.39	1.38
Lime,	.98	..	43.01	7.84	2.36	..	8.45	2.62	4.07
Sweet lemon,	.98	..	54.35	4.29	1.08	..	9.83	4.09	1.32
Tamarind,	1.56	15.57*	..	.68	2.19	..	4.99	1.40	.48
Guava,	.84	1.13	55.00	2.48	1.64	..	8.29	3.58	5.33
Banana (niño),	.70	..	46.46	.95	.42	..	10.36	2.36	6.59
Banana (oronoco),	1.08	..	52.41	1.02	1.90	..	5.16	3.32	8.48
Banana (colorado),	.83	..	51.47	.37	.65	..	3.25	2.77	7.63
Mango (French),	.53	..	47.37	6.38	1.62	..	6.49	3.67	3.88
Mango (Filipino),	.41	1.75	51.79	1.74	3.25	..	9.04	4.88	1.56
Manga,	.78	2.14	49.37	2.38	..	..	5.57	3.84	4.20
Guanabana,	.86	1.48	48.93	.44	2.17	..	9.15	4.54	3.40
Anona,	.80	.63	47.27	.81	2.07	..	13.63	3.19	3.51
Chirimoya,	1.04	..	49.73	2.21	.66	..	6.57	4.49	7.40
Sapota,	.50	..	43.13	7.49	2.83	..	2.74	4.55	17.41
Mamey (colorado),	.80	..	50.57	1.38	1.36	..	4.90	3.54	17.34
Do.,	.89	..	48.20	1.73	3.35	..	9.66	3.80	16.00
Hicaco,	.91	..	35.15	5.84	4.51	..	3.09	4.77	18.62
Caimito,	.35	..	54.75	1.31	..	..	11.00	5.50	9.46
Pineapple,	..	..	59.18	9.44	5.52	..	6.51	3.04	3.22
Do.,	..	..	57.13	4.80	3.44	..	4.29	3.65	4.08

The above data show that the percentage of ash in the edible portion of tropical fruits is never very high. In only three instances in the above table does it exceed one percent and in two of those only slightly. The principal mineral constituent is potash, which in round numbers may be said to constitute one-half of the total ash. Of the acid constituents phosphoric acid is the most important. In four cases the amount of phosphoric acid is greater than 10 percent of the total weight of the ash. The proportion of sulfuric acid in the ash is quite constant, while the amount of chlorin varies from less than one-half of one percent to more than 18 percent.

In this case of high ash there is a low content of phosphoric acid, which leads to the supposition that the chlorin is partially or wholly combined with sodium and potassium. In addition to the elements mentioned above the

* 2.88 percent sand.

ash of edible fruits often contains notable quantities of silica and sometimes considerable quantities of sand, added accidentally or by the collection of dust. The ash of fruit also quite universally contains iron. In some cases the quantity of iron amounts to as much as four percent of the total weight of the ash. The data in the above table are calculated on the percentage of total ash and not on the percentage of pure ash, that is, ash deprived of its carbon, sand, and carbonic acid.

There are some peculiarities in the composition of the ash of tropical fruits to which attention may be called. The citrus fruits contain somewhat larger amounts of lime and iron than ordinary fruits. The ash of the tamarind contains large quantities of silica. The ash of the banana has a low content of lime and magnesia and a high content of chlorin. Attention is also called to the fact that in the ordinary combustion of an organic substance to secure the mineral matter notable quantities of the phosphoric acid and chlorin contained may be lost. Therefore, the data for phosphoric acid and for chlorin are probably lower than would be the case if all of these substances present in the fruit had been secured in the ash. The ash of pineapples is not peculiar in any respect, nor does it contain any marked amount of a constituent by which it can be identified. The pineapple, as is seen, contains slightly more potash than the other tropical fruits.

Sugar and Acid in Fruit.

The palatable quality of fruit depends largely upon the aromatic substances which they contain in the form of essential oils, esters, and ethers, and especially upon their sugar and acid content. The sweet taste of sugar in fruits and also often in nuts is modified and relieved by the acid or astringent materials, chiefly tannin, with which it is associated. In the analyses indicating the composition of fruits and of nuts and also of vegetables the sugar has not always been given separately, but as one member of a group consisting of sugar, starch, and cellulose materials soluble in weak acid and alkalies, and for this reason deemed to be digestible. It seems advisable to supplement this information with a special table giving the average quantity of sugar and acid found in some of the principal fruits. It must not be forgotten that in individual cases the quantity of sugar and acid may vary largely from the average, but the following data may be regarded as expressing very accurately the average content of sugar and acid in the common fruits.

	Sugar. Percent.	Acid. Percent.
Apples, Rhode Island Greening,	10.95	.70 as malic
" Winesap,	11.95	.50 " "
" Northern Spy,	11.80	.70 " "
Apricots, fresh,	11.01	1.15 " "
" dried,	29.59	2.52 " "
Bananas,	20.28	.30 " sulfuric

	SUGAR. Percent.	ACID. Percent.
Blackberries,	5.78	.77 as malic
Cranberries,	1.52	2.34 " "
Currants,	6.70	2.24 " "
Grapes,	7.90–26.40	.59 " tartaric
Lemons,	.37	5.39 " citric
Oranges,	5.65	1.35 " "
Peaches,	7.88	.56 " sulfuric
Pears,	9.11	.19 " malic
Pineapples,	11.50	.60 " sulfuric
Plums,	14.71	.77 " malic
Prunes,	16.11	.32 " "
Raspberries,	5.33	1.48 " "
Strawberries,	6.24	1.10 " "

In the above data the acidity is determined as malic acid in apples, blackberries, and strawberries, in which the predominant acid is malic. In cranberries one of the acids is benzoic, amounting sometimes to as much as 0.05 percent, in grapes tartaric, in lemons and oranges citric. In the other fruits where the character of the organic acid is not distinctly of one kind, the total organic acid is estimated as sulfuric acid (SO_3), not meaning by that, however, that the acids are present in the form of sulfuric acid but merely that their quantity was measured in terms of sulfuric acid.

Canned Fruits.

The industry devoted to canning fruits is of less importance in the United States than that identified with canned vegetables. Practically, nevertheless, every fruit which has been produced in this country has become a commercial article in the form of canned goods. With the exception of the method of preparation, the process of canning and other treatments are essentially the same as that of vegetables and therefore does not warrant any further description.

In the following data are found a brief description and the composition of the leading varieties of canned fruit:

Canned Cherries.—Cherries are one of the fruits which are valued for canning purposes. The pits may or may not be removed, according to the desire of the manufacturer and the demand of the consumer. The galvanic action which the cherry juice sets up on the tin plate tends to bleach the natural color of the cherry, and this action can be avoided by coating the interior of the can with a gum or some similar substance which entirely protects the metallic surface from contact with the juice of the fruit. When treated in this way the natural color of the cherry is preserved for a reasonable length of time.

Adulteration of Canned Cherries.—The only adulteration of canned cherries which is of any consequence is that which relates to artificial coloring. By reason of the tendency to bleach the color, mentioned above, it has been quite customary to add an artificial color to the cherry so that the red color may be preserved. Coal tar dyes, under various names, and an animal dye, cochineal, have been used for this purpose. The practice of artificial coloring is reprehensible and may, in the case of some colors, be harmful to health. By observing the precautions already mentioned, the natural color of the cherry may be preserved without artificial color, and in general this is desirable. The consumer should at all times demand canned cherries which have not been artificially colored.

Maraschino Cherries.—A very common method of treating cherries is to bleach them in a brine of common salt and sulfurous acid until all the natural color has disappeared. The cherries are then thoroughly washed for the removal of the salt and sulfurous acid and at the same time the juice and soluble portions of the cherry are removed, so that at the end of the washing there is little left but the cellular structure. The cherries are then saturated with sugar or sugar and glucose and colored a deep artificial red by coal tar dye or cochineal. If the natural flavor of cherries has been destroyed by the bleaching an artificial flavor is often added. The product is a cherry of an even deep red tint, more or less sweet, according to the use of greater or less quantities of sugar or glucose, and having a flavor of almond oil. When cherries of this kind are preserved in a solution of alcohol, flavored or unflavored, they are called maraschino cherries. The name is taken from a kind of cherry first used in making the product. They are used to a very large extent with certain beverages such as cocktails, soda water, mint juleps, etc., and also in ice cream and other preparations for the table. Little can be said in praise either of the taste or wholesomeness of these preparations and they are valuable chiefly for their supposed attractive appearance. The offense which is committed against the æsthetic taste of the individual in the preparation of such a product probably offsets any good effect which comes from attractiveness or ornamentation. The product cannot be regarded in any sense as resembling even in color the natural fruit, since practically the whole of the natural fruit, except its cellular structure, has been withdrawn and artificial substances substituted in place thereof.

Canned Peaches.—A great industry in this country is the canning of peaches. Some of the finest and most perfect varieties are used for this purpose. Peaches may be canned whole or by slicing in half or quarters and removing the pit. The principles of sterilization are not different from those which have already been described. Since the peach is a fruit which decays easily and is thus difficult of transportation, the establishment of canning factories in the vicinity of large peach orchards renders it possible to preserve this delicate fruit in a condition practically as good as that of the natural article, and thus makes it accessible to the people in all parts of the country at all seasons of the year.

Adulteration of Canned Peaches.—Fortunately in this case there is no record of adulterations which is of any consequence. The perfection of the method of sterilization has rendered it unnecessary to make further use of antiseptics for canned peaches. The use of the artificial sweetening agent, saccharin, is almost unknown and is about the only adulteration which at the present time can be practiced without easy detection. It may be confidently stated that the consumer can rely, with a fair degree of assurance, upon the purity of the product which is taken from the can. The only real danger is in the action of the fruit juice upon the imperfect tin plate, and this is a danger which probably will soon pass away, since there is a tendency manifested now to so protect the tin by a varnish of some kind as to render it impossible for any electric action to take place which impairs the color or flavor of the fruit and also to exclude the poisonous salts of tin and lead from the contents of the can.

Adulteration of Canned Fruit.—*Artificial coloring:* The principal adulteration of canned fruit is that due to artificial coloring. There is, perhaps, no other form of adulteration which has so little excuse. It only needs a cursory observation of the fruits of Nature to show that even in the same varieties they differ to a vast degree in natural tint. Bright colors are especially prized in fruits. For instance, the yellow of the peach, the red of the cherry, the purple of the plum, etc. The object of artificial coloring is to make all kinds and varieties of these fruits imitate those of naturally rich color. Its sole purpose is deception, since it can add nothing whatever to the nutritive value. The claim that it adds to the dietetic value of the fruit, as in other cases of the same kind of argument, is plainly fallacious. The very moment the consumer realizes he is eating an artificially tinted fruit, if he has a temperament that would make him susceptible to suggestion at all he becomes aware of the effort made to deceive him. Such artificially colored foods, thus, instead of tasting better than they otherwise would, have a worse taste due to the feeling of antipathy excited by their presence. Hence there can be no excuse, under any circumstances, for the addition of artificial colors to food products of this kind, or in fact, of any kind except those which are purely synthetic and have no relation in composition or in quality to a natural product. It is a matter of congratulation to know that the addition of artificial color to canned fruits is practically a thing of the past.

Another form of adulteration, which fortunately is seldom practiced in fruit, is one which has already been described in sufficient detail, that is, the addition of saccharin, a substance which has even less place in fruits than in vegetables. The addition of a non-sugar, such as saccharin, with an intensely sweet taste for the purpose of inducing the consumer to believe that the article is a natural sweet product, is an adulteration of the most reprehensible type, to say nothing of the evil effects of the adulterant employed upon health. The addition of spices and other condimental substances to fruit products cannot be regarded as an adulteration, because they reveal their own presence and are not added for the purpose of imitation or deception. As has been mentioned above, the manufacturer would save all criticism in such cases by a plain statement upon the label of the nature of the substance added.

Canned fruits properly preserved retain their natural aroma and flavor better than any other form of canned food and deserve the high estimation in which they are held by the consumer. The time is now rapidly approaching when all such goods will be free of any imitation or adulteration, and this will add greatly to their value in the markets of the country. The consumer will then only need to have the date of preservation marked on the can to be fully protected.

Fruit Sirups.

The expressed juice of fruits mixed with the proper proportion of sugar produces an important article of commerce known as fruit sirup. These fruit sirups are used principally in the preparation of cooling, non-alcoholic beverages such as are drunk at the "soda fountains" so-called in the United States. In the preparation of fruit sirups only the choicest and best fruits are to be used. The juice, after expression, is properly freed from suspended matter by filtration or sedimentation and is brought to a proper consistence by mixing at once with pure sugar. When it is used as soon as prepared no further precaution in regard to its preservation is necessary, since juice prepared in this way and kept in an ice-box will keep several days without fermenting. When manufactured on a large scale for commercial purposes it becomes necessary to prepare these sirups in some more permanent form. To this end they are subjected to the usual process of pasteurization. On account of their liquid condition, sterilization, that is, the use of a temperature of boiling water, is rarely necessary. If, on pasteurization, a precipitate is formed in these sirups, they should be heated to the temperature of pasteurization previous to the final processing and any deposited matter be separated by filtration or deposit. The sirup thus clarified is placed in bottles or separate containers and subjected to the pasteurizing process for a sufficient length of time, and is then ready for the market. These pasteurized sirups, if stored in a cool place, will keep almost indefinitely. In all cases where pasteurization is practiced at a very low temperature it is necessary to keep the product at a low temperature, since, as is well known, pasteurization does not kill all the spores, but does act with deadly effect upon the yeasts which produce alcoholic fermentation. Fresh sirups thus prepared and pasteurized are wholesome and palatable and are unobjectionable.

Naturally the principal added constituent of fruit sirup is the sugar, the other constituents corresponding to those of the juice from which the sirup is made. In other words the natural sugar and that added make up practically the total solids of these products.

Adulteration of Fruit Sirup.—Fruit sirups have been extensively and unnecessarily adulterated. The principal adulteration is the omission of the pasteurization process and the preserving of the fruit juice by means of an antiseptic. The two antiseptics which have been most commonly employed for this purpose are salicylic and benzoic acids. At the present time, by reason of prohibitive legislation in respect of salicylic acid, benzoic acid or its compounds are quite universally employed. These antiseptics are injurious to health and even in small quantities cannot fail to have some deleterious effect upon the system. As they are not necessary in the preservation of fruit sirups, they should be rigidly excluded therefrom. In justice to those who use antiseptics of this kind it is said that, as a rule, they frankly admit that these sirups can be preserved by sterilization, but that when consumed they are used only in small quantities, and when the air has access to the remaining portion fermentation is set up. To this the answer may be made that if unstoppered and used under proper conditions to avoid the admission of germs, and if kept on ice or in a cool place, fermentation will not set up for several days, during which time opportunity will be had for disposing of the contents of the bottle. It does not appear that there is any convincing reason to warrant the continuance of the use of preservatives in this kind of products.

Imitation Fruit Sirups.—By far the most general adulteration of fruit sirups is that of the imitations thereof, pure and simple, by synthetic products, The flavors which give to fruits their character and aroma are chemical compounds produced by Nature and are chiefly of the nature of a volatile oil or compound ether. Of these flavors, the compound ethers especially are readily produced by purely synthetic processes. It is possible, therefore, for the chemist to make an approximate imitation of the natural fruit flavor. No difference how great his skill, however, or the skill of the mixer, there is always a gustatory and hygienic difference between the synthetic and the natural product, and the natural product always has the advantage of the difference. While I do not go so far as to say that synthetic flavors or sirups should be excluded in the preparation of non-alcoholic beverages, I do say with emphasis that they should never be used, except with notificaton to the consumer, and never, under any circumstance, if they contain any ingredient which is prejudicial to health.

One of the principal arguments which has been made against the enactment of the pure food bill has been that it would exclude from the market these synthetic products. At least let them be sold under their proper designations. A law which requires plain and honest branding can hardly be objected to on any ground whatever.

Jams, Jellies, and Preserves.

The preparation of various fruits or fruit juices with sugar is an important industry both for domestic purposes and for commerce in the United States. When the fleshy portion of the fruit is treated with sugar sirup and boiled, it produces the product known as preserves. When a fruit is reduced to a pulp and treated with sugar sirup and boiled, it makes a product known as jam. When the fruit juice itself is treated with sugar and boiled, it forms a product known as jelly. The above are general definitions of three important classes of fruit products, though it is not intended by any means in the definitions to describe the details of preparation. These vary greatly in respect of the method of preparation, the fruit, the quantity of sugar used, the length of time the boiling is continued, and the consistency of the final product. These definitions merely outline the three distinct classes of products which are made from fruits.

Selection of the Fruit.—In the selection of the fruit for making these sweet products it is highly important that only the very best quality should be used. The fruit should be of a proper degree of maturity, and yet not overripe. The practice of using immature, waste, or partially deformed or decayed fruit for the purposes named cannot be too strongly condemned. The great advantage of preparing these products at the home consists in the fact that the character of the material used is under the immediate supervision of the housewife. In large factories where no official inspection is exercised it is possible that any kind of fruit or any portion of the fruit may be devoted to the purpose. All deteriorated raw material should be rigidly excluded from the factory. Various fruits are utilized in different manners in the preparation of the above-named products. Large fruits with tough skins, such as apples, peaches, and pears, are pared, the cores removed, and all decayed or infected portions cut away, and the clean, fresh, fleshy portion of the fruit used for manufacturing purposes. Small fruits, such as berries, after the exclusion of all dirt, immature or imperfect samples, and the removal of the stem, are used in the whole state for the purposes named.

It would be manifestly impracticable, as a rule, to remove even the seeds of small fruits, except where jelly is to be manufactured. The fruits, having been properly prepared, are mixed with sugar or thick sugar sirup and subjected to heat for two purposes. The first purpose of heat is to sterilize completely the material so that no bacteria, germs, or spores may be left alive in the finished product. The second purpose of heating is to concentrate the material to a proper consistence and to thoroughly saturate all portions with sugar sirup. Incidentally, the heating also by the combined action of temperature and free acids in the fruit inverts a large quantity of the cane sugar that is used and thus prevents the finished product from granulating. The crystallization of the sugar in these bodies renders them very much less desirable and less suitable for preserving. For this reason, among others, the precaution mentioned, namely, that the fruit should not be overripe, should be observed. It has been seen that overripe fruit diminishes in acidity, and hence it is less suitable for converting the cane sugar than fruit just short of complete maturity. For this reason, too, the more strongly acid fruits are better suited for making these sweetened products than those in which the acidity is less strongly developed.

Jams.—As has already been said, jams differ from jellies in that they contain not only the juice of the fruit but the whole pulp of the fruit or the whole fruit. The methods of preparation in effect produce the same changes upon the sugars that are produced by the fruit juice. The fruit after proper comminution is boiled with large quantities of sugar a sufficient length of time to reduce the fruit flesh to a pulp and to invert more or less of the sugar which is used. The insoluble matter which jam contains consists chiefly of the cellulose and pectose matter in the fruit, together with the seeds of the small fruit. The various solids are made up of the solid bodies in the fruits, including the sugars which are added. The character of the ash of the jams is a good indication whether or not they are pure, that is, made out of sugar and fruit only. While it is true that the ash of fruit varies, it is also true that the real ash of fruit has certain characteristics in regard to alkalinity which are not possessed by the ash of adulterated fruit products. For the sake of convenience and reference it is seen advisable to append a table showing the composition of the ash of some of the fresh fruits (Bulletin 66, Bureau of Chemistry).

FRUIT.	PURE ASH	K_2O. POTASH.	Na_2O. SODA.	CaO. LIME.	P_2O_5. PHOSPHORIC ACID.	SO_3. SULFURIC ACID.	Cl. CHLORIN.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Apple,	0.264	55.21	11.69	4.79	12.83	4.62	0.83
Apricots,	.508	59.36	10.26	3.17	13.09	2.63	.45
Banana,	1.078	63.06	2.34	.86	1.62	2.32	26.93
Cherries,	0.440	57.67	6.80	4.20	15.11	5.83	1.83
Figs,	.682	57.16	2.38	10.90	12.76	3.90	2.05
Grapes,	.500	50.95	6.32	4.96	21.27	4.28	1.54
Lemons,	.526	48.26	1.76	24.87	11.09	2.84	.39
Oranges,	.432	48.94	2.50	22.71	12.37	5.25	.92
Prunes,	.486	63.83	2.65	4.66	14.08	2.68	.34

From the above table it is seen that there is not a very large percentage of sulfuric acid in the natural ash of fruits, and very little chlorin, with the exception of the banana, in which the ash is principally potassium chlorid. Since the ash of glucose, as it is made at the present time, consists almost entirely of sulfates and chlorids, any considerable increase of these ingredients of an ash over the normal may be regarded as an indication that the fruit product from which the ash is obtained contains added glucose. Inasmuch as there are chemical and physical methods of detecting glucose which are entirely reliable, the utility of the composition of ash for this purpose is rather confirmatory than otherwise. Since the added sugar is the chief constituent of jams there is little difference in other respects in the composition of jams made from different fruits, as will be seen by the table of analysis given below:

Description.	Total Solids.	Acidity.	Reducing Sugar.	Cane Sugar.	Total Sugar.
Jams.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Apple,....................	63.22	0.282	25.52	29.11	54.63
Blackberry,................	55.42	.851	18.77	29.00	47.77
Grape,....................	56.64	.744	33.44	11.33	44.77
Orange,..................	80.52	.433	13.61	54.23	67.84
Pear,.....................	61.52	.163	13.20	33.74	46.94
Peach,....................	65.65	.500	36.48	23.16	59.64
Pineapple,................	73.92	.314	14.05	46.40	60.45
Plum,.....................	50.43	1.012	28.29	9.70	37.99

The characteristics of fruit which give the special flavors to the jams are imparted by constituents such as ethers, essential oils, and other aromatic substances, together with the free acids which are present in such quantities as not to be susceptible of easy quantitative determination by chemical means. The relation which exists between the cane sugar and the invert sugar is not a safe index of the method of preparation, but is rather an indication of the excess or deficiency of the acid in the fruit employed. The greater the quantity of active acids, other things being equal, the larger the quantity of inverted sugar and the smaller the quantity of cane sugar in the finished product.

In the following table is given the composition of a number of jams made in the laboratory of the Bureau of Chemistry. These analyses are selected from a great many which are available because the character and amount of sugar in the composition of the jam were carefully controlled, and thus the chemical data afford a base of direct comparison.

Serial Number.	Description of Sample.	Total Solids.	Ash.	Total Acids Expressed as H_2SO_4.	Proteids (N × 6.25).	Sugars. Reducing sugar.	Cane sugar added.	Cane sugar found.	Cane sugar inverted.	Polarizations. Direct at 18° C.	Invert at 18° C.	Invert at 86° C.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	°*V.*	°*V.*	°*V.*
20446	Apple (fall pippin) . .	63.22	0.20	0.282	0.175	25.52	51.31	29.11	43.22	+26.3	−13.0	+4.8
20414	Blackberry	55.42	.48	.851	.737	18.77	43.99	29.00	34.08	+24.6	−14.6	+1.6
20445	Grape (fox)	61.80	.19	.698	.200	50.06	54.21	3.70	92.96	− 9.0	−14.0	+2.2
20416	Grape (Ives seedling)	56.64	.48	.744	.525	33.44	42.45	11.33	73.38	+ 3.5	−11.8	0
20443	Orange (Florida navel)	80.52	.44	.433	.944	13.61	69.13	54.23	21.55	+55.9	−17.5	+2.0
20448	Pear (Bartlett)	61.52	.28	.163	.312	13.20	46.52	33.74	18.87	+32.3	−13.2	+1.0
20442	Pineapple	73.92	.30	.315	.312	14.05	60.20	46.40	22.90	+52.3	−10.3	+6.2
20421	Plum (damson) . . .	50.43	.54	1.102	.525	28.29	37.75	9.70	74.42	+ 3.1	−10.0	+1.2
20423	Plum (wild fox) . . .	62.10	.46	1.355	.212	28.78	47.86	23.26	53.43	+13.9	−17.5	0

The following table represents the data relating to the composition of jams from samples purchased in the open market, free from glucose and apparently pure:

Description.	Total Solids.	Acidity.	Reducing Sugar.	Cane Sugar.	Total Sugar.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Apricots,..................	70.15	.407	38.96	26.00	64.96
Currants,..................	66.32	1.117	52.45	1.64	54.09
Figs,......................	69.89	.744	....	45.92	....
Grape fruit,...............	69.20	.387	27.00	35.51	62.51
Guava,.....................	82.46	.299	25.14	52.73	77.87
Peach,.....................	65.65	.500	36.48	23.16	59.64
Strawberries,..............	75.83	.480	37.15	31.43	68.58

The average composition of a large number of pure jams, some of which were made in the laboratory and some purchased in the open market, is as follows:

Data.	Total Solids.	Acidity.	Reducing Sugar.	Cane Sugar.	Total Sugar.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Average,..................	65.98	.536	36.41	22.15	58.56
Maximum,..................	82.46	1.355	61.02	54.23	....
Minimum,..................	50.43	.163	13.20	.30	....

The analytical data show that the jams, in so far as active food constituents are concerned, are composed chiefly of sugar. These sugars include both that natural to the fruit and that which has been added. The average content of sugar in round numbers is 58.5 percent, while in round numbers the average content of solids, not sugar, is 7.5 percent. It is thus seen that the amount of sugar present in round numbers is eight times as great as that of the other solids. It is also noticed that the percentage of reducing sugar is about one-third greater than the cane sugar, indicating that the inversion of the sugar, when the real fruits have been used in the manufacture, has been carried to such an extent as to avoid any danger of crystallization. These data are all in complete refutation of the claims made by many manufacturers that it is necessary to add glucose in the manufacture of complex products of this kind in order to prevent crystallization. If the real fruit is used in the proper quantity and the manufacture conducted according to the approved method, there is no danger of crystallization except in those rare cases where the fruits used have little or no acid.

Adulteration of Jams.—The adulterations of jams are practically the same as those which are practiced with jellies. Artificial colors have been very extensively used together with the artificial flavors resembling the fruits, the names of which appear erroneously upon the packages. Glucose is used to a large extent in these adulterated goods. In the adulterated articles a preservative is nearly always present. Starch is used but very rarely for adulterating articles of this kind.

Fifty-eight samples of jams which proved to be adulterated were bought on the open market by the Bureau of Chemistry, none of which bore any label or description indicating that it was an adulterated article. The character of the principal adulterant (glucose) in each case is revealed at once by the polarization, which is always strongly right-handed, and also by other chemical tests for glucose. The quantity of sulfate and chlorid in the ash of these samples is always very considerably increased over that of the natural product. The quantity of glucose in some of the samples is so great as to indicate that practically the whole of the solid matter is composed of this substance. In two samples the alleged jam contained no fruit product whatever. In many cases more than 70 percent of glucose is found and in one instance as high as 76 percent. In a great majority of the cases the glucose is approximately one-half of the whole weight of the jam. In a great many cases the glucose was present in quantities which indicated the utilization of some fruit product. There were a few cases where the amount of glucose fell below 10 percent. Artificial coloring matter was present in almost every case, and in the great majority of cases either benzoic acid or salicylic acid is present as a preservative. The colors used are coal tar dyes and cochineal.

It is evident that articles of food adulterated in this manner should not be permitted to bear the name of the natural product, and in many of the states the local laws forbid the use of a misleading name. The national law, which was approved on the 30th of June, 1906, also forbids misbranding of this description.

In addition to the jams which on their labels bore no indication of the adulterations, a number of samples of jam were purchased labeled "Compound," or in some way indicating that they were not the pure article. Thirteen samples of this kind were examined in the Bureau of Chemistry and all of them had very large quantities of glucose, the largest amount present in any one case being 37 percent. They were all artificially colored, and ten of them contained preservatives, either benzoic or salicylic acid.

Jellies.—In addition to the jellies which were made in the laboratory of the Bureau of Chemistry for the purpose of controlling the investigation, 44 samples of jelly were bought upon the open market. Of these commercial samples 19 contained no glucose, 13 of them contained glucose, but were not so labeled, and 12 were labeled as compound or adulterated articles. Nearly all of the commercial jellies were made with apple juice as the base. The apple juice and glucose made up practically the total solids, no matter what name was applied. The flavors were artificial, and a very large number of the samples contained preservatives. The samples of jelly which contained no glucose were evidently made of the natural fruit,—they contained no artificial coloring matter and in only a few instances did they contain preservatives. On the other hand the jellies which were made of glucose were uniformly colored and contained preservatives.

It is of interest here to say a few words about the very cheapest of adulterated jellies which are found upon the market. These jellies were made with some apple juice, but chiefly of glucose. They contained large quantities of preservatives, and the ash was rich in sulfates and chlorids except in two instances. In these cases it is possible that the glucose which was used was manufactured by some special process not involving the use of either sulfuric or hydrochloric acid.

Adulteration of Jelly.—Jellies are of the class of fruit products which have been extensively adulterated. The markets of the country have been flooded for years with so-called "compound jellies" or imitations of jelly. The chief forms of adulteration are the following: The use of apple stock for making all kinds of jelly. Attention has already been called to the fact that apples contain a large number of pectose bodies which favor jellification. A common method of manufacturing jelly has been to use a stock of apple juice or cider or a preparation made from the cores, skins, and rejected portions of the apple at evaporating factories or from whole rejected apples. This stock is used as a common base for the manufacture of jellies of different kinds. Whenever apple juice enters into the composition of a jelly made from any other fruit than the apple it becomes an adulteration. Phosphoric and other acids are added to jellies to enable jellification to take place with the use of less fruit and more water.

Artificial Coloring.—In as much as each kind of fruit tends to give to a jelly a particular color, it is evident that if apple stock is used the natural colors of the other fruits must be imitated.

To this end coal tar dyes have been generally employed, and sometimes vegetable or animal coloring matter to imitate the color of the fruit whose name is given to the product.

Artificial Flavors.—Since when apple stock is used as a base of manufacture it imparts to the finished product only the flavor of apples, artificial chemical flavors resembling other fruits are employed. Thus the jellies which, presumably, are made from other fruits, have the particular flavor of those fruits imitated in a wholly artificial way.

Composition of Jelly.—The properties of a jelly, in respect of its distinct character, are due solely to the fruit from which it is made. Each one of the fruits contains essential oils, ethereal substances, acids, etc., which give to it a distinct character. These bodies are carried with the fruit juice into the finished product and give to it its distinct characteristics. The sugar, of course, in all these products is the same. In the following table are found the data showing the composition of jellies made from different fruits in the Bureau of Chemistry.

COMPOSITION OF JELLY.

Serial Number.	Description of Sample.	Total Solids.	Ash.	Total Acids Expressed as H_2SO_4.	Proteids (N × 6.25).	Sugars.				Polarizations.		
						Reducing sugars.	Cane sugar added.	Cane sugar found.	Cane sugar inverted.	Direct at 18° C.	Invert at 18° C.	Invert at 86° C.
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	°V.	°V.	°V.
20408	Apple (fall pippin)	59.18	0.22	0.279	0.175	20.78	51.76	33.04	36.17	+24.0	—20.6	—1.2
20405	Blackberry	59.63	.33	.475	.243	12.51	54.89	44.90	18.20	+47.0	—20.1	0
20410	Crab apple	63.28	.11	.171	.137	34.93	57.61	23.68	58.88	+13.0	—19.0	0
20405	Grape (Ives seedling)	63.66	.45	.524	.175	32.29	60.29	30.52	49.33	+22.3	—18.9	+ .2
20412	Huckleberry	63.02	.28	.245	.069	24.27	53.39	32.74	37.54	+24.1	—20.1	— .4
20435	Orange (Florida navel)	68.56	.30	.171	.418	3.95	65.59	62.52	4.91	+61.3	—23.1	— .2
20437	Peach	69.98	.21	.245	.175	8.75	63.70	56.59	11.16	+53.4	—23.0	— .6
20434	Pear (Bartlett)	69.12	.34	.181	.156	6.58	63.09	58.46	7.33	+52.7	—26.2	—1.8
20436	Pineapple	80.28	.43	.328	.387	22.13	72.98	56.70	28.45	+50.4	—26.1	0
20433	Pineapple husk	76.34	.73	.352	.350	7.40	70.22	65.22	7.12	+63.7	—24.3	— .6
20404	Plum (damson)	45.56	.68	1.127	.350	19.18	38.00	22.67	40.38	+17.8	—12.8	0
20409	Plum (wild fox)	54.49	.40	1.029	.138	24.00	48.05	25.48	46.97	+16.7	—17.8	0
20411	Plum (wild fox), boiled down	73.01	.65	1.529	.175	44.22	64.66	22.37	66.18	+ 7.6	—22.6	— .6
20407	Mixed fruit	66.58	.21	.367	.069	39.70	59.72	24.22	40.38	+14.8	—17.9	+2.2

As is to be expected the chief constituent of these jellies is the sugar which is derived from two sources—that in the natural juice and that added in the manufacture. The data show that the quantity of cane sugar inverted varies greatly with the different fruits. Some of the fruit juices appear to have little or no effect whatever in the inversion of sugar. This is particularly true of the orange, the pear, and the jelly made from the husks of pineapples.

Manufacture of Jellies.—In the manufacture of jellies the fruit juices are separated from the pulpy mass of the fruit, and these alone are used in the process. The most common method of procedure is to boil the fruit with more or less water until the juices are more or less separated and then to remove them by straining or pressure. The fruits are heated for this purpose with sufficient water to prevent scorching until they are thoroughly softened and then reduced to a pulp. The best jellies are made from juices which are obtained by simply allowing the pulpy mass to drain through cloth. The juices thus obtained are clear and free of any suspended matter. When pressure is used the juices are less clear and contain more or less suspended solid matter. In the preparation of jellies approximately equal portions of pure cane sugar and the strained juices are used, and the mixture is boiled for a few minutes. It is evident that in the manufacture of jelly where boiling is not continued for any length of time the amount of sugar inverted is less than in the manufacture of jams and preserves where the boiling is continued for a greater length of time.

The quantity of non-crystallizing material in the juices from which the jellies are made, namely, the pectose bodies in fruits, is sufficient in most cases to prevent the crystallization of the cane sugar in the jelly. The jelly is formed by these pectose bodies being present in the juice in sufficient quantities to become semi-solid on cooling after manufacture. The solidifying may take place in a short time or only after several hours. The juice at the time of completion of the boiling is thoroughly sterilized, and in this hot condition should be placed in sterilized vessels and covered before setting away with sterilized parchment paper or a thin film of sterilized paraffine. The covering of the surface will prevent the deposition of the seed of moulds and bacteria which often infect the top layer of jellies or other fruit products prepared in a similar manner whose surface is not properly protected.

Preservatives.—Since the care which is necessary to prepare a jelly in a thoroughly sterilized condition and to protect the exposed surface so that infection thereof cannot take place is a matter of expense and requires great attention to details, it has been sought to avoid these by the use of chemical preservatives. Salicylic acid and benzoic acid or benzoate of soda have been the principal preservatives employed, and until state and municipal laws introduced a proper inspection or analysis of these products the use of these chemical preservatives was very common. In later years their use has been gradually diminished, owing to the objections on the part of the laws and the public to the presence of these bodies in the finished products. There are, however, still on the market many products which are preserved by salicylic acid, benzoic acid, or benzoate of soda or some similar active agent.

From the above résumé it is seen that the consumer who buys in the open market is not quite certain that he is getting the product for which he pays. This condition of affairs will doubtless pass away with the advent of the proper inspection of fruits which are used in manufacturing on a large scale and a proper supervision of the manufacturing establishments, together with a rigid execution of the national and state food laws. Under such conditions the adulterations will either disappear from the market or be so labeled as to practically inform the purchaser of their character.

Marmalade.—The term "marmalade" is applied to a special character of fruit product prepared in the same manner as jam in which the fruit is not so thoroughly pulped. The orange is a fruit which is used very extensively for making marmalade,—an orange marmalade, in other words, is only a fruit product of the character of jam and made after the same manner. This class of fruit products is so nearly the same as jam as not to need any special description.

Adulteration.—The adulterations to which the marmalades are subjected are practically the same as for jams. In the study of marmalade in the Bureau of Chemistry 96 samples were examined. Of this number 86 were commercial products and 10 were prepared in the laboratory of the Bureau. Of the commercial articles 18 samples, somewhat less than 20 percent, contained no glucose. Fifty-three contained glucose, but were not so labeled, and 15 were labeled as compound or artificial. The percentage of solids in these products varied within a wide limit. The maximum percentage of solids found was 82.46 and the minimum 53.43. The average percentage of ash in the marmalade not containing glucose was 0.32, and the average alkalinity of the ash as measured by a standard acid was 0.26. In the adulterated marmalade containing glucose the average percentage of ash was 0.59, almost as great as in the pure article, and the average alkalinity was 0.29, somewhat greater than in the pure article.

Compound Jams and Jellies.—A word should be said respecting the meaning of the word "compound" as attached to fruit products, especially jams and jellies, since it is a word which has been selected as somewhat more euphonious than the term "adulterated" or "misbranded." So true is this that the word "compound" when placed upon a food product indicates at once to the purchaser that the article is a mixture or substitute. The term, therefore, indicates the character of sophistication. To such an extent may this be practiced that the actual material named in connection with the word "compound" may be absent from the mixture altogether. The term arose first on account of the desire of the manufacturer to leave off of the labels a statement of the exact composition of the contents of the package and to substitute a word of less significance, and at the same time to comply with certain state laws which require that all fruit products containing glucose be labeled with the word "compound" or some similar term. A much simpler and more direct method would be to make the label a truthful one, indicating, as nearly as possible, the character of the product. A compound generally means a jelly or jam made without the fruit named, that is, largely of glucose. It also indicates, as a rule, that the product is artificially colored and artificially flavored. In these cases the word "imitation" is to be preferred, inasmuch as the mixtures bearing the word "compound" can only be regarded in reality as a mixture of unlike substances.

General Conclusions.—In regard to fruit products made by boiling with sugar, the general statement that they should be true to name and free from artificial colors, preservatives, or other adulterations apparently covers the whole ground. If it is desired to make a cheaper article for the benefit of consumers of small means, the principles which should guide the manufacturers are plain. The materials which are added should be wholesome and free from deleterious or injurious matter. The poor man, while entitled to get a cheaper article, is likewise entitled, as well as the rich man, to protection from deleterious substances. In the present state of our knowledge, glucose is not regarded by the majority of hygienists as a substance injurious to health. If it be injurious it is due more to a lack of care in manufacture than to any inherent properties. Glucose, however, has been found injurious to bees and is not a natural product such as maltose and sucrose. The objections to glucose which have been legitimately made are due to the fact that the acids which have been used in converting the starch and also the sulfurous acid which has been used in bleaching the product have not been entirely removed. It appears that the glucose used for food purposes can be freed from all objection by inverting the starch from which it is made with diastase and avoiding the use of all bleaching reagents. The glucose thus made would not be water-white, nor is it desirable for edible purposes that it be so, since it is always, except, perhaps, in the manufacture of certain candies, used in connection with naturally colored food products. There is no reason to believe that a glucose made as described and possessing, as it naturally would, an amber or reddish color would be less desirable than a product which is absolutely colorless. This suggestion, therefore, is made to the manufacturer of glucose for edible purposes in the interest of public health and to avoid any possible condemnation of the glucose by reason of the method of manufacture, namely, that the use of acid in the manufacture of glucose be discontinued, that malt or some other form of diastase be substituted and that bleaching, except by passing through animal charcoal, be entirely omitted. The product made in this way would be free from the objections which have been, and may in the future still be, urged with reason against its use.

Preserves.—The term "preserves" is a general one which is applied in common language to a preparation of fruit preserved by boiling with sugar until complete sterilization is accomplished. The term in its general application includes the different varieties of preserves which have already been mentioned, namely, jams, marmalades, etc. It must also be extended to include the class of fruit products known as jellies, though, as a rule, it is not made so comprehensive in meaning, inasmuch as the jelly does not contain any of the solid particles of fruit. Perhaps there is no other part of the food-manufacturing industry which is so universally practiced in the household as the manufacture of preserves. Not only is this true of farm life in the country but also of those living in the city. The sterilization of fresh fruit without the use of sugar is not nearly so common as the making of the domestic supply of preserved fruits in the sense above mentioned. There is only one sufficient reason for the preparation of such foods, namely, the suspicion which attaches to the manufactured article appearing upon the market. So universal has been the custom of artificially coloring the product, and of the use of glucose and preservatives, as to create a general impression among consumers that the articles thus purchased in the open market are adulterated and misbranded. When these preparations are made in the household we are at least assured of the genuineness of the product. It must be admitted that the art and technique of manufacture cannot possibly be so perfect in the home as in the large factories. It follows as a necessary consequence that such goods as those indicated ought to be better and cheaper and more readily preserved if made in large manufacturing centers than when made at home. Even those who make the genuine product suffer in common with those who make adulterated articles, since the suspicion of adulteration attaches to the whole output. The practice of domestic manufacture will undoubtedly continue until the public is fully convinced that better and cheaper articles can be purchased in the open market.

Peach Preserves.—A common practice among the housewives throughout the United States is to boil peaches with sugar or sugar sirup, forming the well known product, peach preserves. Preserves of this kind are considered a delicacy, and, as they are easily made and kept, they are a very common article of diet throughout all parts of the country where peaches are grown.

Fruit Butter.—There are several preparations of fruit which differ in some respect from those just mentioned, to which the term "butter" has been applied, such as apple butter, peach butter, etc., and these are common articles of domestic manufacture. This type of article is illustrated by a description of apple butter.

Apple butter is made by boiling comminuted, sound, carefully selected apples of a proper degree of maturity with cider until the whole mass forms a bulk of the proper consistence. The preparation thus made is treated with certain spices according to the desire of the manufacturer and the taste of the consumer. There is quite a quantity of material insoluble in water in genuine fruit butter. The rest consists of water, the added sugar, if any, and the fruit juice with which the butter is made.

Adulteration of Fruit Butter.—Very extensive adulterations are practiced in the case of some commercial fruit butters. In the Bureau of Chemistry as high as 30 percent of glucose has been found as an added product. The addition of cane sugar cannot be regarded as an adulteration but the best fruit butters are made without it. Artificial colors are sometimes used, and preservatives, especially benzoic acid, are quite common in the commercial article.

Brandied Fruit.—The use of brandy in common with sugar in the preservation of fruit is widely practiced. Sometimes alcohol alone is relied upon as a preserving agent. At other times greater or less quantities of cane sugar are used. Usually heat is employed in addition to the other preserving agents to complete sterilization. Nearly all forms of fruit may be preserved in this way. Brandied cherries and peaches are perhaps the most abundant. The quantity of alcohol employed varies between 15 and 20 percent of the total weight of the goods. The quantity of cane sugar used has been found to range from six to 20 percent of the weight of the fruit. Fruit preserved in this way cannot be regarded in the light of food solely, but only as a condimental substance. The eating of any large quantity of food containing that percentage of alcohol could not be accomplished without danger of intoxication. The utilization of such foods upon the table should be of a restricted character, and, especially, they should not be used with children or very young people where the danger from the direct effects of the alcohol is magnified and the possibility of forming the alcohol habit is also present.

Adulteration of Brandied Fruits.—The principal adulteration of brandied fruit is in the use of aclohol which is not genuine brandy. It is well known that much of the brandy offered in commerce is fictitious, that is, is not the pure distilled alcoholic product from sound wine properly aged in wood before using. When brandy is purchased for preserved fruit, unless special care is taken to secure the genuine article the imitation article may be supplied. Instead of the real brandy the manufacturers may use an article which is entirely devoid of any product of the distillation of wine or containing only a small amount thereof. The term "brandy" used with the fruit in such a case is a misnomer and the article would be deemed misbranded under the provisions of the law. The manufacturer can assure himself of the purity of the brandy by obtaining it from a bonded warehouse, since it is made under the supervision of the officials of the internal revenue and kept under such supervision until delivered to the consumer. Inasmuch as preparations of this kind are regarded as delicacies and the cost of the product does not enter materially into consideration it is highly advisable that only genuine brandy, distilled from sound wine and aged in wood for a period of not less than four years, be employed in the manufacture.

Importance of the Canning and Preserving Industries.—The statistics for the canning and preserving industries for the calendar year ending December 31, 1904, form a part of the census of manufactures, which is made in conformity with the act of Congress of March 6, 1902, and are compared with similar statistics for the census of 1900, which covered the fiscal year ending May 31st.

There has been a large increase in these industries. The slight decrease in the average number of wage-earners is more apparent than real, and is due largely to the fact that a considerable number were employed in fish canneries under a contract system. The contractor furnishes the laborers and is paid for an agreed quantity of product. The establishment reporting has no record of the number employed by the contractors, and they were not included in the number reported, the amount paid for such contract work being included in the item of miscellaneous expenses. Fishermen were not included in the census, and it is possible that a larger proportion of the salted fish was prepared in connection with the actual catch than at the census of 1900, thus accounting in part, at least, for the decrease in the quantity.

CANNING AND PRESERVING FRUITS AND VEGETABLES, AND FISH AND OYSTERS.

COMPARATIVE SUMMARY—CENSUSES OF 1904 AND 1900.

	1904.	1900.	PERCENT OF INCREASE.
Number of establishments,	2,687	2,182	23.1
Capital,	$69,589,316	$47,970,787	45.1
Salaried officials, clerks, etc.:			
Number,	3,604	2,418	49.0
Salaries,	$3,216,773	$1,926,639	67.0
Wage-earners:			
Average number,	50,258	51,955	3.3 [1]
Wages,	$14,154,730	$12,759,459	10.9
Miscellaneous expenses,	8,544,497	3,290,459	159.7
Materials used,	69,814,330	52,243,948	33.6
Products: [2]			
Aggregate value,	$107,534,464	$81,020,384	32.7
Fruits and Vegetables—			
Total value,	$72,570,974	$44,460,665	63.2
Canned Vegetables—			
Pounds,	1,672,759,438	1,142,327,265	46.4
Value,	$45,262,148	$28,734,598	57.5
Canned Fruits—			
Pounds,	295,760,355	293,637,273	.7
Value,	$11,644,042	$11,311,062	2.9
Dried Fruits—			
Pounds,	343,579,623	81,189,406	323.2
Value,	$15,664,784	$4,415,005	254.8
Fish—			
Total value,	$24,452,533	$20,542,691	19.0
Canned—			
Pounds,	259,469,861	167,836,808	54.6
Value,	$15,966,513	$14,308,723	11.6
Smoked—			
Pounds,	35,439,619	21,252,066	66.8
Value,	$2,362,740	$973,041	142.8
Salted—			
Pounds,	112,156,655	125,669,131	10.8 [1]
Value,	$6,123,280	$5,260,927	16.4
Oysters—			
Value,	$3,799,412	2,054,800	84.9
All other products,	6,711,545	$13,962,228	51.9 [1]

[1] Decrease.

[2] Exclusive of fruits and vegetables valued at $715,920, fish at $274,403, and oysters at $12,900, manufactured by establishments classified as food preparations, pickles, preserves and sauces, slaughtering and meat packing, wholesale, etc.

Importance of the Industry.—The importance of the canning industry is not to be measured solely by its commercial extent. The principle of the conservation of food products by sterilization or pasteurization is of immense significance in the nutrition of man. It enables nourishing foods of a perishable character to be kept and transported to great distances and to be used in localities where fresh foods of similar kinds are otherwise unobtainable. Such preserved foods mean everything to pioneers, explorers, armies, and navies. The "winning of the west" in the United States has been marked by the débris of the rusty cans. The roads along which the pioneers who settled the great American desert marched since 1865 have been bordered with the discarded packages in which they carried their foods.

It is doubtless true that foods when they can be had fresh are to be preferred to those which have been sterilized. It is also true that many unsterilized foods from unsanitary environments are more dangerous in the fresh state than when they have been exposed to a high temperature. Taking into consideration all the circumstances in the case, it must be conceded that the process of sterilization, first practiced by Appert and afterward placed on a scientific basis by Pasteur, has proved of almost immeasurable advantage to mankind. Thus for this greater reason the character and quality of foods thus preserved should be wholly above suspicion, and no adulteration or sophistication of any kind should be practiced therewith. The manufacturer is quite as much interested as the consumer in placing the whole output of sterilized foods on a plane above suspicion.

Character of the Container.—Much in the direction of securing a better product may be accomplished by a more careful selection of the container. The common method of preserving canned goods is in tin. This material, as is well known, is placed on the surface of sheet iron and should be free of other metals. Lead especially should be excluded from the composition of the tin as far as possible. In spite of all these precautions, however, the coating of the tin is sometimes broken so that the iron itself may be attacked, perforations result, and the package of goods be spoiled. More frequently, however, the erosion of the tin plate occurs over widely extended areas, introducing into the contents of the package a considerable quantity of tin salts. This may be prevented to a certain degree by coating the surface of the tin with a gum or varnish which is not acted upon by the contents of the package. Glass is also coming into more general use, and if it could be secured of a character to avoid breakage it would be possible to replace to a considerable extent the tin packages now in such common use and thus prevent the introduction of soluble tin salts into the food. In this case the glass itself should be free of lead, borax and fluorids. A glass package is now coming into use which is tough and resistant to ordinary causes of fracture. Much may be expected from progress in this direction.

PART VII.

VEGETABLE OILS AND FATS, AND NUTS.

VEGETABLE OILS AND FATS.

The production of a substance known as fat or oil, composed of oxygen, hydrogen, and carbon in the form of a fatty acid and combined with glycerine, is a function of almost every plant. The fat acids are usually in combination with glycerine, which plays the part of a base and in so far as its proportion by weight is concerned is much less important than the fatty acid itself. In round numbers it may be said that nine-tenths of all glycerids or fats are composed of a fatty acid and one-tenth of glycerine. When at ordinary temperature this combination is in a liquid form it is called an oil, and when at ordinary temperature it is in a solid or semi-solid condition it is known as a fat. The term "ordinary temperature" means in this connection that of an ordinary living room and not the extremes of outside temperature. In general terms it may be said that the temperatures referred to are included between the minimum of 50 degrees and the maximum of 85 degrees F. In so far as chemical composition and dietetic properties are concerned, there is no distinction between the oils and the fats. The names are simply a means of ordinary discrimination which has assumed importance by reason of common usage.

There are three of the fatty acids which are particularly important from a dietetic point of view which go to make up the greater part of these fatty and edible vegetable oils and fats. These three acids are oleic, stearic, and palmitic. Of the three, oleic acid is by far the most important, as it constitutes the greater part of nearly all these bodies, especially of oils. In fact the term "olein" and oil are of common origin. Palmitic acid exists chiefly in certain forms of vegetable oil and fats, while stearic acid is a very important constituent of animal oils and fats.

These three acids uniting with glycerine form the glycerids which make up the great body of edible and animal oils and fats, and these principal glycerids are known as olein, palmitin, and stearin, respectively.

Chemical Characteristics.—The chemical composition of these bodies has been pointed out above. There is, however, in almost all cases, some free acid present in the compound, that is, an acid which is present uncombined with the glycerine. This free acid is usually present in small quantities and is more abundant in the overripe and older plants than in the freshly matured parts. The natural oil also contains certain other ingredients which may be regarded as impurities, and which it is necessary to remove from the oils by a process of purification or refining before they are ready for the table. These impurities may be of a mechanical nature, that is, consisting of parts of the material itself from which the oil is expressed or of certain juices not oils which are found in the plant tissue, portions of protein and other forms of nitrogenous matter, and traces of carbohydrates and gums. The oils have certain definite chemical reactions which are common to them as a class. Among these may be cited, principally, the faculty of absorbing, under certain conditions, the halogens, namely iodin, bromin, and chlorin.

Without entering into any technical description of this process it is sufficient to say here that the degree of absorption of iodin is in a measure the test for the varieties of oil. The different vegetable oils have, as a rule, certain definite relations to the absorption of iodin by means of which they may be to a certain extent identified or separated from similar bodies. The degree of absorption is expressed in the percentage by weight of the oil itself and is known as the iodin number. If, for instance, a gram of any particular oil absorbs one gram of iodin, it is said to have an iodin number of 100. Many oils absorb more than their own weight of iodin, while many others absorb very much less. Another characteristic of oil is found in the fact that with certain reagents, such as an acid either in a dilute state or in a concentrated state, definite colors are produced which are characteristic of the variety of oil in question. As an example of this may be cited the faculty which cottonseed oil has of reducing nitrate of silver to the metallic state, leaving the silver in that finely divided form which has a black color. This is the only oil in common use which has this faculty, and hence it may be regarded as a characteristic test.

Another characteristic chemical property of cottonseed oil is the color which is produced in the Halphen reaction, which has already been described.

One of the most valuable chemical properties of oil is the amount of heat which is produced when it is burned. Inasmuch as oils in relation to their food value are useful chiefly for the production of animal heat, this chemical property becomes of great hygienic and dietetic significance. Of all classes of food products the oils and fats have the highest calorific power. If, for instance, it is said in general that one gram of carbohydrates, such as sugar or starch, on complete combustion will yield 4,000 calories, one gram of protein 5,500 calories, then one gram of oil or fat will yield 9,300 calories. The fats and oils vary among themselves in respect of the number of calories yielded, but all of them give, approximately, the number last mentioned. It therefore follows that oils and fats are the most valuable constituents of food in respect of the production of heat and energy.

Crystalline Characteristics.—The forms of crystals which the fats assume on solidifying are valuable indicators of the nature of the oil. While these crystal forms are not in all cases distinct, yet they are influenced to a greater or less extent by the nature of the oil itself. Thus the presence of any particular oil may very often be ascertained by the examination of the crystals produced by lowering the temperature very slowly or by dissolving the oil in a volatile solvent and gradually evaporating the solvent. Tests of even greater delicacy may be obtained by first saponifying the fat or oil, separating the fatty acid, and subjecting it to crystallization.

Distribution of Oils in Plants.—In nearly all cases the part of the plant which contains the most oil is the seeds. In fact all of the vegetable oils which are used for edible purposes are extracted from the seed of the plant. In the case of olives the meaty portion around the seed yields the edible oil of highest value, but in all other cases of edible oils they are derived from the seeds themselves. It is a mistake to suppose that the seeds are the only parts of the plant that contain oil. It is found in all parts of vegetable substances, but is usually concentrated in the seed. It is rather an interesting fact to know that in the seeds of plants both the protein and fats or oils are found, as a rule, in a highly concentrated state, while the carbohydrates are not found chiefly in the seed itself, that is the germ, but distributed in the fleshy envelope surrounding it or in roots or tubers.

The oils and fats are almost all soluble in ether and petroleum ether, though there are some exceptions to this, as in the case of castor oil, which is also insoluble in petroleum ether or gasoline. On the contrary, oils and fats, as a rule, are not soluble in alcohol, but the fatty acids derived from them are. Castor oil is also an exception to this rule, since it is quite soluble in pure alcohol.

Drying and Non-drying Vegetable Oils.—It might be supposed that if one vegetable oil is edible they all would be. This would probably be the case if vegetable oils were all composed almost exclusively of the three classes of glycerids, which have just been mentioned, but this is not true. There are other fatty acids in combination with the glycerids which exist in vegetable oils, and chief among these may be mentioned linoleic acid, which exists in considerable quantities in the oil of flax seed, and gives to it its valuable property of a drying oil which makes it so useful in the manufacture of paints. Whenever vegetable oils and fats contain any especial quantity of linoleic acid, or any other fatty acid which has drying properties, they are rendered more or less unfit for human consumption. The number of drying oils is very great, but the most important are linseed oil, hempseed oil, and poppyseed oil. Other vegetable oils have, to a certain degree, drying properties, and among those which are most marked in this particular may be mentioned cottonseed oil, sesamé oil, maize or corn oil, and rapeseed oil. Types of the oils which have the least drying properties and which are regarded as types of non-drying oils are olive oil and peanut oil. The castor oil group is distinguished partially from the other vegetable oils because it contains, or is likely to contain, more or less of a somewhat poisonous substance, namely, ricinolein, which is peculiar to castor oil and to which its purgative value as a medicine is due. The castor bean also contains a very poisonous nitrogenous base, ricin, very small quantities of which may be incorporated in the oil itself.

Melting Point and Solidifying Point.—The oils and fats differ greatly among themselves in the temperature at which they become solid or liquid. If a solid fat or oil is subjected to a gradual rise of temperature it does not pass at once or suddenly from a solid to a liquid state, but there is a gradual liquefying,—thus olein first becomes liquid and the stearin and palmitin become liquid at a higher degree of temperature. The same phenomenon in its inverse order occurs when a liquid fat is cooled until it solidifies. The moment at which the fats become semi-liquid, liquid, or semi-solid, therefore, is not to be determined with absolute precision, but only approximately, and that temperature is designated as the melting or solidifying point respectively. When the process is carefully conducted under standard conditions the different fats and oils have very definite melting or solidifying points, as determined in the manner described above, and these temperatures should be sufficient to make the melting and solidifying points valuable indications of the character or kind of oil.

Physical Characteristics.—The difference in the physical characteristics of vegetable fats and oils is even greater than in their chemical composition. Unfortunately for the chemist, the vegetable fats and oils naturally have about the same color or at least very slight variations therefrom, namely, an amber tint, so that, as a rule, it is impossible to discriminate between these oils by their mere color alone. The edible oils also have very much the same taste, so that this physical property is not of any very great diagnostic value. Some of the more important physical properties by which the oils are distinguished are the following:

Refractive Index.—The well-known phenomenon which is shown by water of bending sharply a ray of light falling upon it in a direction oblique to its surface is known as refraction, and the degree of deflection of the ray is a measure of the refractive index. This is easily illustrated by putting a straight stick or rod into still water at an angle to its surface. The stick or rod will appear to be broken or bent at the surface. Oils have a higher faculty of deflecting the ray of light than water. For instance, if in round numbers the refractive index of water is represented by 1.33, the refractive index of oil may be represented by 1.47. The oils differ greatly among themselves in the magnitude of the refractive index, but these indexes are all approximately of the magnitude last mentioned. Hence a determination of the refractive index is a valuable means of helping to discriminate between oils of different kinds.

Reichert-Meissl Number.—Attention has been called to the fact that in addition to three special forms of fatty acids there were many others present in oils in small quantities. Among these are found acids which are volatile in a current of steam, which is not the case with the oleic, palmitic, and stearic acids. Among the most important of the volatile acids is the one which exists in large quantities in butter, namely butyric acid. The quantity of volatile acid is determined arbitrarily by the amount of a standard alkali solution which will be neutralized by the volatile acid from five grams of fat. In the case of butter, for instance, it may be said that in round numbers it requires 28 cubic centimeters of standard alkali to neutralize the volatile acid produced according to the above method of procedure. In cottonseed oil the amount of standard solution required to neutralize the volatile acid obtained in the same way is extremely minute, amounting to less than one-half cubic centimeter.

I have given above a brief description of some of the physical and chemical characteristics of oils and fats in order that the reader not specially trained in chemistry may understand thoroughly the references made to these properties in the general description given of vegetable fats and oils. It is not necessary to be a skilled chemist in order to have a general knowledge of some of the points which are of most interest in this respect.

Saponification Value.—As is well known, one of the most common uses of oils and fats is in soap making. Soap consists of the products of chemical reactions by means of which the glycerine contained in an oil or fat is set free and a mineral or other base substituted therefor. For instance, lye consists of the hydrate or carbonate of potash and soda. When an oil is heated with a lye the fatty acid leaves the glycerine in the oil and combines with the potash or soda of the lye. The number of milligrams of potash or soda required to saponify one gram of fat or oil is called its saponification value. For instance, in the case of cottonseed oil it requires, in round numbers, 190 milligrams of potash or hydrate of potash (KOH) to replace the glycerine in one gram of oil. The quantity of potash required for an edible oil to make a complete saponification varies, and hence this number becomes one of the means of distinguishing between them.

Specific Gravity.—The relative weight of a given volume of oil compared with the weight of the same volume of water at the same temperature or at some standard temperature is known as its specific gravity. The oils and fats are universally lighter than water, and in the comparison the unit weight of water is assumed to be unity or 100 or 1000—usually unity or 1000. If the relative weight of water is unity, then the relative weight or specific gravity of oil is expressed as a decimal fraction. For instance, if water is taken as unity the specific gravity of oil equals .912; if the relative weight of water is assumed to be one thousand then the specific gravity expressed above is 912. Unless it is stated otherwise, in all references to specific gravity of these oils it is assumed that the comparison is between the unit weight of water and oil at the same temperature. This is the most convenient form for comparison for general use, though for strictly scientific purposes it is customary to refer all specific gravity numbers to water at the temperature of its maximum density, namely 4 degrees C. (39 degrees F.). At this temperature a given weight of water has its smallest volume, in other words its greatest density. When water is raised to a temperature above that mentioned, it expands and its volume becomes larger. When it is cooled to a temperature below four degrees C., its volume also expands.

The variations in the specific gravity of the common oils is not very great, and therefore the specific gravity is not the most valuable indication in discriminating between these oils.

Edible Vegetable Oils.

While there is very little chemical difference between the fats of animals and the oils of plants, the difference is sufficiently distinguished to secure a proper degree of identification and classification. Both classes of bodies are composed of the fatty acids combined with glycerine. The three fatty acids which are most important from the edible point of view and also from the chemical are oleic, stearic, and palmitic. When these acids are united with glycerine as the basic element, they form three classes of oils or fats to which the names olein, stearin, and palmitin are respectively given. A distinction may also be made between a fat and an oil by observing its physical consistence at ordinary room temperature of approximately from 70 to 80 degrees F. It is usual to speak of the bodies which are liquid at such temperature as oils, while those that are solid under like conditions are known as fats. A compound of this description does not pass suddenly from one state to another. In the case of a fat, for instance, which is solid at ordinary temperature, it passes by gradual stages from that condition to a slowly softening mass and then to a complete liquid as the temperature is raised. On the other hand, an oil passes gradually through the same stages to the condition of a solid body as the temperature is lowered. Of the different constituents the olein has the lowest melting point, pure olein being still liquid at quite a low temperature, approaching even the freezing point of water. Stearin and palmitin on the contrary, if in a pure state, are solid at a temperature even above that of the room and above that of blood heat.

In the mixture of these bodies it is evident that a complicated structure must be present which is composed of different bodies of varying melting points which pass, when subjected to different degrees of temperature, from a solid to a liquid state or vice versâ. It is evident that an oil has a larger proportion of olein in its composition and a fat a larger proportion of stearin and palmitin.

Animal fats are composed chiefly of olein and stearin, while strictly vegetable oils are principally olein, and palm oil is composed chiefly of stearin and palmitin.

In butter fat there is introduced an important additional compound of a fatty acid with glycerine, namely butyrin, which is made up of a union of glycerine with butyric acid. Butter also contains other components or glycerids, but in small quantities. Oleic, stearic, and palmitic acids are insoluble in water and not volatile at the boiling point of water. Butyric acid is soluble in water and is volatile at the boiling point of water. The first kinds of acid are therefore called "fixed" and the second "volatile."

The edible vegetable oils like the animal fats are highly nutritious in the sense that they afford to a greater degree than any other kind of food product the elements necessary to the production of heat and energy. The average number of calories to one gram of edible oil is in round numbers 9,300. When this number is compared with the average number of calories in one gram of sugar or starch, namely 4,000, it is seen that fats and oils are two and one-fourth times as valuable as sugar in the production of heat and energy. Since the greater part of the food consumed by an animal is utilized in the production of heat and energy, it is seen that the fats and oils must be classed as the most concentrated and in that sense the most valuable human foods.

The use of edible vegetable oils is also advisable for hygienic purposes. They are readily assimilated and digested. and they produce a physical effect upon the process of digestion which is a matter of importance. The free use of edible vegetable oils is to be recommended in cases of constipation or where there are mechanical difficulties in the digestive process. In these cases it is consumed in larger quantities than would ordinarily be the case.

Use of Edible Oils.—The edible oils are used most extensively on the table as the base of salad-dressing. Many succulent vegetables, as has already been stated, are eaten very commonly with condimental substances such as vinegar, salt, spices, etc., and as a vehicle for these condimental substances there is nothing superior or even equal to the edible vegetable oils. Vinegar, itself, owes its active principle, namely, its acid, to a member of the fatty acid series, so that the mixture of vinegar with oil is not a bringing together of two wholly different substances but of two substances belonging to the same general family. Vinegar itself has no value as a food, but is useful solely for condimental purposes. On the other hand the edible oil is not only condimental, increasing the pleasant taste of the compound, but also has a high food value. Edible oils may also be used in the place of lard and other animal fats in the preparation of bread and pastry, serving the purpose of shortening. They are also highly useful as a vehicle for frying foods, such as oysters, croquettes, doughnuts, etc.

The heating of an oil or fat to a high temperature produces a certain degree of decomposition with a development of an aromatic and sometimes unpleasant product known as acrolein. It is not believed that this change is as detrimental to digestion as is commonly supposed. Products which are fried in oil, or boiled in oil, which is probably a better term, as described above, are not to be considered wholly indigestible, though it cannot be denied that they are not the best things for delicate stomachs or those which are in any way weakened by disease. In the case of a healthy individual, however, a moderate quantity of such products may be eaten without any great danger of producing a derangement of digestion. If these bodies are found to be indigestible, it is probably not due to the fact that they contain large quantities of oil but rather to the decomposition effected by the high temperature and the hardening of the periphery of the bodies to such an extent as to make them difficultly amenable to the activities of the digestive ferments.

Acorn Oil.—The oil of the acorn is sometimes used for edible purposes. It is extracted by pressure, and the nature of the product depends upon the variety of the acorn. Acorn oil has at 15 degrees a specific gravity of .916 and an iodin number of 100. It is not of any commercial importance as an edible oil.

Almond Oil.—Almond oil is not so commonly used for edible purposes as it is for pharmaceutical preparations. By reason of its flavoring properties, however, it may sometimes be used for food purposes, and a brief description, therefore, is advisable.

Almond oil is obtained from the seed of the bitter almond, a variety of *Amygdalus communis* L. It may also be extracted from the seeds of the sweet almond, but these contain less oil than the bitter almond seed and the oil is not so useful for flavoring purposes. The bitter almond whose seeds are used for the extraction of oil are grown chiefly in Morocco, the Canary Islands, Portugal, Spain, France, Italy, Sicily, Syria, and Persia. The almond kernel contains about 40 percent of oil. Almond oil is said by most observers to be free from stearin, and it is therefore an oil which is composed almost exclusively of olein. The specific gravity of almond oil at 15 degrees C. is almost exactly that of rapeseed oil, being only a trifle higher. The average number expressing the specific gravity at that temperature is .918. Its iodin value is slightly lower than that of rapeseed oil, being about 97.

Adulterations.—Almond oil is often adulterated with other cheaper oils, and among those which are principally used are cottonseed oil, walnut oil, poppyseed oil, sesamé, peanut, apricot-kernel and peach-kernel oil, and lard oil.

Those most frequently used are the apricot and peach, since these oils contain the characteristic principle which gives the bitter taste to the kernels of this class in fruits. Often almond oils are offered to the trade which are composed exclusively of peach-kernel or apricot-kernel oil. Whenever the iodin number of an almond oil runs very high it is an indication that it is composed largely of peach or apricot oil. The detection of small quantities of these oils when added to almond oil is a very difficult matter and can only be accomplished by the expert chemist.

Cottonseed Oil.—One of the most important edible oils in the world, and especially from the point of view of production in the United States, is that derived from the seed of the cotton plant (*Gossypium herbaceum*).

The cotton plant grows over a wide area in the United States, including all of the southern states and extending into southern Virginia, southern Kentucky, southern Missouri, and Oklahoma. In former years the cotton plant was cultivated solely for its fiber. It is only in the last quarter of a century that the high value of its seed for many purposes has been realized. The seed of the cotton plant is preëminently rich in oil and protein. It contains traces of certain poisonous alkaloids, betain and cholin, the presence of which renders its indiscriminate use for cattle food in some cases dangerous. In the preparation of oil, however, no trace of these poisonous substances is found, since they exist solely in the non-fatty tissues of the seed. The production and refining of the oil have now grown to be a great industry and have already added much to the wealth of the cotton growers and the comfort and nutrition of the people in general.

Magnitude of the Cottonseed Oil Industry.—The average cotton crop of the United States is nearly 12,000,000 bales of about 500 pounds each. For every bale of cotton there is produced 1,000 pounds of seed. This would make the average cottonseed crop of the country about 6,000,000 tons. It is estimated that not over two-thirds of this is used in the mills; this would make about 4,000,000 tons. The average yield of 40 gallons to a ton shows the production of crude oil to be 3,200,000 barrels of 50 gallons each. This oil in refining loses on the average about 8 percent, which would leave 2,944,000 barrels of refined oil for edible and other purposes. Not less than two-thirds of this oil is used for edible purposes. A conservative estimate would place the quantity used for food between two and two and a half million barrels per annum. The quantity varies with the prices of other fats.

Cotton seed is brought to the mills from the gins either by rail in box cars or in wagons. On arrival at the mills, it is stored in large sheds, known as seed houses. A single seed house will often contain as much as 5,000 to 10,000 tons. The seed is carried into the mill by means of conveyers. It first goes through coarse screens which remove the greater part of the trash and sand, after which it is passed over magnetized iron plates which remove nails and pieces of iron which may have accidentally gotten into the seed. After the seed is thoroughly cleaned it passes through gins known as linters, which remove from 40 to 50 pounds of short staple cotton known in the trade as "linters." This cotton is used for preparing cotton batts, mattresses, etc. Conveyers carry the seed from the linters to the hullers, which are rapidly revolving drums covered with cutting knives which chop up the seed. From the hullers the cut-up seeds pass over a series of screens where the meats are shaken out while the conveyors carry the hulls to a storehouse or to the furnace if not used for cattle food. The meats are carried to the crusher rolls, through which they pass. These rolls break up oil cells to a large extent and leave the meats in a finely divided condition. From the crusher rolls the meats are carried to steam-jacketed kettles provided with agitators. There they are cooked to the proper point, which is determined by feel and smell. From the heaters the meats are dropped into cake formers, where they are made into the shape of cakes between camel's hair press cloths in which they are placed in the heavy hydraulic presses which press out the oil. Good press-room work will give out 45 gallons of oil to the ton and leave in the cake between 6 and 7 percent of oil.

The crude oil as it leaves the presses varies in color from light sherry to deep claret. The variation is due to local conditions affecting the seed, also the manner of treatment in cooking. The flavor of the crude oil varies greatly in the different parts of the country. That made in Georgia and Carolina has a strong flavor of peanut, while that made in the Mississippi Valley and Texas has more the flavor of sweet Indian corn.

Further Details.—The cotton seed from various sources is put through a screen to take out the bolls and coarse material. The seed is then put through a gin to remove as far as possible any remaining lint, of which about 20 pounds per ton of seed are obtained. The clean seed is next sent to a huller composed of revolving cylinders covered with knives, which cut up both seed and hull. The chips are then conveyed to a screen placed on a vibrating frame, through which the kernels fall. The hulls are carried by an endless belt to the furnaces, where they are burned. The kernels of the seed are conveyed to crusher rolls, where they are ground to a fine meal. The meal is then sent to a heater, where it remains from twenty to forty minutes. These heaters have a temperature of 210 to 215 degrees F.

The hot meal is formed into cakes by machinery; these are wrapped in cloth and placed in the press. About sixteen pounds of meal are put in each cake. The cakes are placed in a hydraulic press, where a pressure of from 3,000 to 4,000 pounds per square inch is applied. The press is also kept warm. The expressed cakes contain only abot 10 percent of oil. The cake is sold as cattle food or for fertilizing purposes. The crude oil as thus expressed contains about 1.5 percent of free acid, also a notable quantity of water and solid matters in suspension. The manufacture of cottonseed oil usually takes place in the winter months immediately after the ginning of the cotton is completed. The oil is likely to become rancid if kept unpurified until the hot months. The crude oil is collected in oil tanks at the press and shipped to the refining houses. In the winter when the tanks are sent to the north where the temperature is very low the contents of the tank become solid unless protected from the action of the cold.

Refining Process.—The first step in the refining of a crude cottonseed oil is to have it stored in large and deep tanks where it remains at rest for a proper length of time. During this period of rest the heavy mechanical impurities and water settle to the bottom of the tank and are typically known as "foots." The oily portions of these foots are used in the manufacture of soap and for other technical purposes. The tanks may be furnished with steam jackets in order to

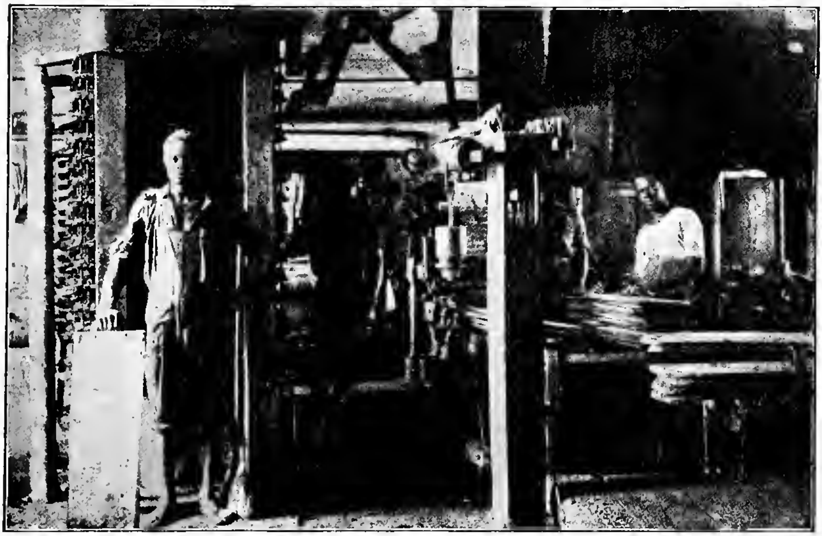


FIG. 57.—REMOVING THE OIL CAKES FROM A COTTONSEED PRESS.—(*Courtesy of David Wesson.*)

keep the oil at a proper temperature. During the process of deposition the oil is also treated with an alkali to neutralize the free acid which it contains. The precipitate formed by this process together with the principal part of the soaps produced are recovered with the "foots." A solution of caustic or carbonated soda is one generally employed in this process of refining. If the admixture of caustic soda occurs at the time of filling the tank, the contents are kept well agitated for a sufficient length of time to secure an intimate mixture of the oil with the lye. Usually the deposition of the solid matter is accomplished in from two to three days. The supernatant oil is of a light yellow color, but not sufficiently pure to admit of being used for edible purposes. This yellow oil is treated again in a similar manner and allowed to settle a second time, or it is mixed with some substance which will facilitate the operation, and subjected to filtration by means of which a perfectly bright oil is secured. If, during this process, the oil has never been chilled so as to separate a part of its stearin, it is called summer oil, as an indication that it only remains clear during the hot weather. Oils intended for winter use are chilled before finally being put into packages, and the stearin which is separated at this low temperature is removed by filtration. The residual oil which is capable of remaining liquid at a low temperature by reason of the removal of a portion of its stearin, as above described, is known in the trade as winter oil. In this process of filtration fuller's earth is frequently employed, which not only promotes the filtration but also absorbs and retains a large part of the color of the oil, which thus treated is almost colorless. Where cottonseed oil is used for mixing with lard it is highly important that it be practically free of color. When, however, it is used for mixing with oleomargarine the more yellow it is, the more highly prized.

In the final preparation of cottonseed oil for edible purposes, particularly if it is to be used as a salad oil, a special process of refining is advisable in order to remove the last traces of foreign matter and to secure freedom from any distinctive taste or objectionable color. To this end many of the steps already described are repeated, or perhaps it might be better expressed by saying that the oil is subjected to a second refining process, the reagents already named being used in varying quantities, usually with the application of a gentle heat, and the mass is then left to settle until a clear, light, greenish golden oil is obtained. Unless the oil is refined in this particular way it is apt to develop a disagreeable odor on cooking and to impart an unpleasant taste to articles in which it is cooked or to which it is added. Sometimes it is necessary, in order to remove all of these disagreeable and objectionable qualities, to refilter with fuller's earth until the residual oil is almost colorless, but the fuller's earth is apt to leave a flavor in the filtered oil, and this is in turn removed by treatment with steam. The details of this deodorizing process vary and are regarded as trade secrets. The oil so prepared is largely used in the preparation of substitutes for lard and similar cooking fats. Such oil is a great improvement over the ordinary summer yellow and bleached products, but falls short of being an ideal oil. Within the last few years a cottonseed oil has been put on the market in which the objections to the use of cottonseed oil as food have been as nearly overcome as the chemical nature of the oil will permit. The oil produced by this process is practically odorless and tasteless and can be used satisfactorily for all culinary purposes. Large quantities are used by the bakers in place of lard. It is difficult to compare this doubly refined oil with other edible oils and especially with olive oil. It may be said, however, that such an oil is of excellent quality and perfectly satisfactory to those who have not acquired a taste for olive oil. The introduction of wholesome and palatable vegetable oils at a lower price than olive oil will promote a more general consumption of such oils without any unfair competition with olive oil which will continue to hold its place as the premier table oil of the world.

Extraction of Oil by Means of Petroleum.—The light oils which are produced in the refining of petroleum and commonly called gasoline are typical solvents for fat and oil. Instead of extracting the oil by the pressure process, as described above, a practically complete extraction may be secured by successive treatments with the light petroleum oils. The principle of the process is exactly that of the extraction of sugar from sugar beets by hot water in the process of the manufacture of beet sugar. The cottonseed cake or pressed meal is broken into fragments of approximate size, placed in tanks, and treated with successive portions of light petroleum. The extraction is arranged in such a way as to be a continuous one, that is, the vessels for handling the oil cakes are arranged *en batterie* as in the case of beet sugar extraction. By this method all except a mere trace of the oil is extracted from the cake. The light petroleum oils are subsequently separated from the cottonseed oil by distillation and are used again in the process. There is little loss of petroleum oil. Where cottonseed oil is used for technical purposes there is no objection to this method of extraction, and much is to be said in its favor since greater yields of oil are secured. When used for edible purposes, however, petroleum extracted cottonseed oil is not of as high a quality as that extracted by pressure. It is difficult to remove all traces of petroleum, especially the odor, and there are constituents extracted by petroleum which are not mixed with the oil when it is separated by pressure. It is advisable, therefore, that cottonseed oil used for edible purposes be cold-press extracted and not petroleum extracted oil.

Standard for Cottonseed Oil.—The official standards for cottonseed oil are as follows:

"Cottonseed oil is the oil obtained from the seeds of cotton plants (*Gossypium hirsutum* L., *G. Barbadense* L., or *G. herbaceum* L.) and subjected to the usual refining processes; it is free from rancidity; has a refractive index (25 degrees C.) not less than one and forty-seven hundred ten-thousandths (1.4700) and not exceeding one and forty-seven and twenty-five ten-thousandths (1.4725); and an iodin number not less than one hundred and four (104) and not exceeding one hundred and ten (110).

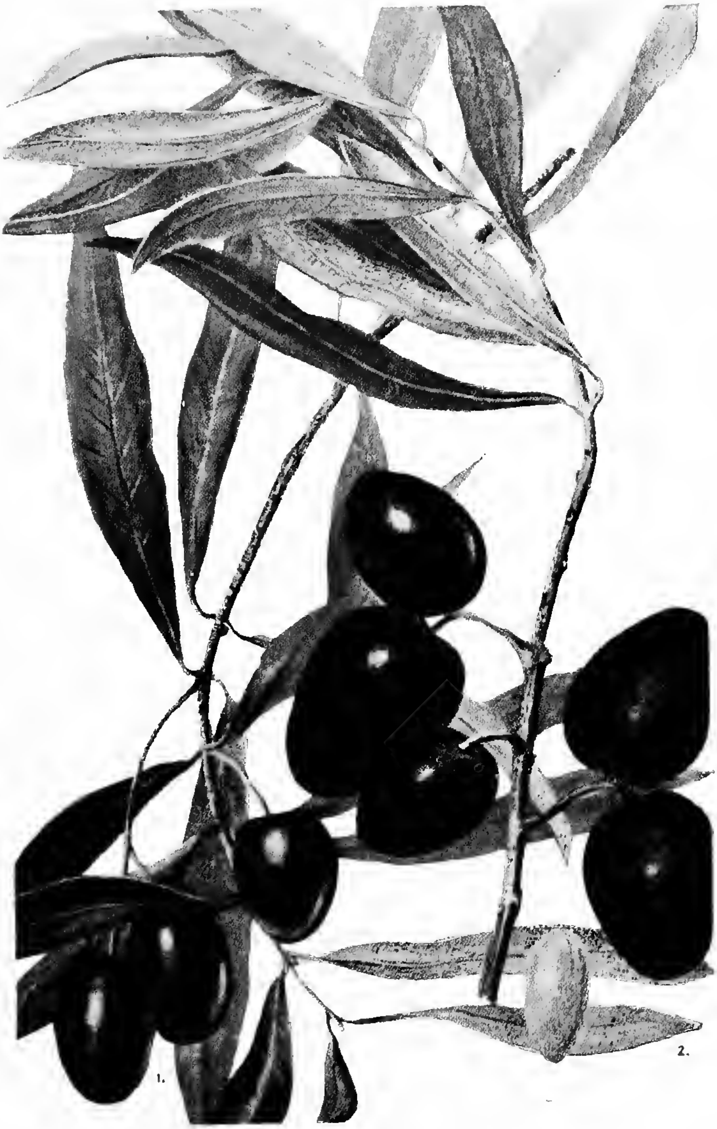
"'Winter-yellow' cottonseed oil is expressed cottonseed oil from which a portion of the stearin has been separated by chilling and pressure."

Hazelnut Oil.—The oil of the hazelnut is to a limited extent used for edible purposes. It is extracted from the seed of the hazelnut tree (*Corylus avellana* L.). The seeds are very rich in oil and are said to contain from 50 to 60 percent thereof. The oil is almost free of stearin, being said to contain only about one percent. The rest of it consists chiefly of olein, there being but 12 percent of palmitin. While this is an edible oil, it is used chiefly in the manufacture of perfumes and as a lubricating oil. Its high price, however, excludes it from any general use, except for special purposes. Its specific gravity at 15 degrees is .916, and it absorbs about 86 percent of its weight of iodin.

Olive Oil.—By far the most important of edible oils, both on account of its abundance and of its palatability, is olive oil. Olive oil has been used from the earliest historical times and probably was the first vegetable oil that was manufactured to any considerable extent in the early history of civilization. Its qualities have maintained for it a market among the nations of the world in spite of the fact that many other palatable and wholesome vegetable oils have been produced which, while not inferior in nutritive value to olive oil, are so very much cheaper that unless the olive oil possessed peculiar properties it would be forced out of the market. Its delicate flavor, extreme palatability, high nutritive power, and other general characteristics have maintained for it a market against the strongest competition.

Olive oil is procured from the fruit of the olive tree (*Olea Europæa* L.), and when it is to be used for edible purposes the method of extraction is by pressure. When olive oil is used for technical purposes, such as lubricating and the manufacture of soap, it is very commonly secured by extraction with a volatile solvent, such as petroleum. The olive is very rich in oil, the quantity varying from 40 to 60 percent. The quality of olive oil upon the market varies in a very great degree according to the country from which it comes, the degree of maturity of the olive from which the oil is extracted, the method of expression employed, and the character of the refining process to which the expressed oil has been subjected. Botanically, there are very many varieties of olive trees and thus nature would impart to the olive peculiarities due to the origin of the oil itself. The environment also has a great deal to do with the character of the olive and necessarily with the character of the oil produced. The olive tree flourishes best in semi-arid regions where the rainfall is not very abundant and the sunlight is not greatly obscured by clouds and the heat is reasonably high. The principal regions, at the present time, from which the commercial olive oils are obtained are Spain, Italy, Greece, southern France, and southern California.

Adulteration of Olive Oil.—By reason of its great value as an edible oil and its high price there is no one of the edible oils which has been subjected to such a systematic and extensive adulteration. By reason of the resemblance in general character of many of the edible vegetable oils to olive oil, adulterations of the most extensive character may be practiced without indicating to the eye any change in composition. Nearly all the edible vegetable oils have the light amber tint which is characteristic of many grades of olive oil, and the difference between the color of the olive oil and other edible oils is not greater than the difference between the tints of the various olive oils themselves. The connoisseur of extremely delicate taste is usually able to distinguish by the flavor any



OLIVES

1. MISSION 2. SEVILLANO

From Yearbook, U. S. Dept. of Agriculture, 1897

given edible oil from olive oil. If, however, any given edible oil be mixed with olive oil in small proportions not exceeding 25 to 30 percent, even the skilled taster will be deceived. In such cases only the chemist who has much skill and practice is able to detect the adulteration.

Adulteration with Cottonseed Oil.—In the United States the principal adulteration of olive oil is with cottonseed oil. This is an oil which has already been described as of high nutritive value and to which no objection can be made from any hygienic or dietetic point of view. It is made in great quantities in the United States, and when subjected to the most careful refining processes can be offered to the consumer at a price probably not greater than one-fifth that of high-grade olive oil. It becomes the ideal material with which to adulterate olive oil. This adulteration extends often to complete substitution, the oil in question, though represented as olive oil both by the dealer and the label, containing no trace whatever of that substance. Such bare-faced substitution has apparently almost passed away under the quickening ethical sense of the manufacturer and merchant and the character of the national and state laws. Many of the oils which are used to adulterate olive oil have a greater specific gravity, hence whenever the specific gravity of an olive oil at 15 degrees goes above .917 it is ground for suspicion of adulteration though by no means a positive proof. The presence of cottonseed oil in olive oil is easily detected by the Halphen test, which has already been described. In Europe a very common method of adulteration is with sesamé oil, the properties of which are described below. Peanut oil is also extensively used for the same purpose. These two oils are easily detected when mixed with olive oil. The sesamé oil is distinguished by the color reaction to be described. Peanut oil is distinguished by the saponification of the oil, separation of the fatty acids, and consequent crystallization of the arachidic acid, which produces a crystalline form which is readily recognized by an expert. Rapeseed oil and poppy-seed oil are also extensively used as adulterants in Europe, but not very extensively in this country. Nearly all the oils which are employed in the adulteration of olive oil have high iodin numbers, and therefore whenever an iodin number is above 89 or 90 it may be regarded as a suspicious circumstance. There are, however, many genuine olive oils which would be condemned as adulterated if this test alone were employed. In addition to the oils mentioned, small quantities of castor oil, lard oil, fish oil, and even of petroleum oil, have been found as adulterants in olive oil. These, however, occur very infrequently, and it is not likely that they have been employed in this country.

If the examination shows that a given sample is free of cottonseed, sesamé, and peanut oil, and other characteristics of the sample are those of olive oil, it may be safely accepted as a pure sample.

Color of Olive Oil.—The color of the freshly expressed olive oil is usually green or dark from the chlorophyl and other coloring matter derived from the olive. When refined and ready for commerce the oil is of a yellowish-green tint usually. Sometimes the oil obtained from the first pressing is almost colorless, but as a rule an amber-green tint is observed in most of the commercial varieties. Lower grade oils are often decidedly green, but still edible, due to the admixture of chlorophyl from the green olive employed. The flavor of olive oil is a pleasant and agreeable one, but differs greatly in oils from different sources. The further north the oils are produced the less pronounced the flavor and the sweeter the taste. The more southern oils, such as are obtained in the south of Italy and Spain, have a stronger and more pronounced flavor which, however, is very much prized by those accustomed to it. Large quantities of olive oil are produced also in the French and other possessions in the north of Africa. These, however, have a stronger flavor than those produced upon the continent of Europe and are not so highly prized when used alone. Olive oil is almost free of stearin, being composed chiefly of olein with some palmitin. The amount of free acid in olive oil varies with the character of the olives employed and the age of the oil. On long standing, without becoming rancid, olive oil develops a large quantity of free acid. It is a common supposition that rancidity in an oil depends upon the development of free fatty acid, but this is not the case. If an oil be free of rancidity it may contain a large percentage of free acid without becoming inedible. It is not uncommon to find in olive oil as high as 3 percent or more of free acid. This is due to the fact that in the refining of olive oil alkalies are not usually employed, and therefore any free acid which the natural olive possesses is not neutralized by the alkalies, as is the case in the refining of cottonseed oil and some other vegetable oils.

Constituents of Olive Oil.—Olive oil consists almost exclusively of olein and palmitin. There is very little, if any, stearin in the highest grade oil. If all the solid fatty acid at ordinary temperature be regarded as derived from palmitin, the quantity of palmitin may be considered as varying from 3 to 20 percent, according to the origin and character of the sample. While the olein and palmitin, therefore, may be regarded as the principal constituents of olive oil, there are others, also, existing in smaller quantities. The quantity of free fatty acid varies very greatly in olive oil. It is highly important that the oil be separated from the pomace as speedily as possible, since any fermentation of the pomace increases the quantity of free fatty acid. The largest number of high-grade oils contain less than three percent of free fatty acid, but a larger quantity, as has been stated, does not render the oil inedible unless actual fermentation has taken place producing rancidity. Rancidity appears to be the result of the generation of other acids than oleic, and also aldehyds, formic, butyric, acetic, and œnanthylic acids have been found. Olive oil is a typical non-drying oil and therefore shows less rise in temperature when mixed with sulfuric acid than other vegetable oils. The specific gravity of olive oil at 15 degrees may be placed at the average figure of .917. It sometimes falls as low as .912 and rises as high as .919. It absorbs from 80 to 90 percent of its weight of iodin. In some samples the weight of iodin absorbed is less, falling as low as 77 percent, but this is only in very extraordinary cases. Occasionally it goes above 90 percent. Probably the number 87 would represent about the mean percentage of iodin absorbed by most edible oils.

Method of Preparation.—The very finest quality of olive oil is that derived from the hand-picked olive. Just as in the preparation of fruits for the market the very best qualities are carefully picked one by one from the tree, so in the preparation of the highest grade of oil the olives are picked one by one, only those of uniform maturity and character being selected. This specially selected fruit is pressed cold, and the first running from this pressure collected separately is designated in English by the term "virgin oil." Virgin olive oil, therefore, ranks the highest in quality. Unfortunately the use of the term for commercial purposes has not been restricted to the quality of oil to which it actually belongs, and at the present time the expression "pure virgin olive oil" which is placed upon the bottles or containers is no guarantee that this quality of oil is found therein. In fact, this expression upon the label has been found in many instances of olive oil highly adulterated and belonging to the cheapest grade. It would be impossible here to enumerate all the different names by which olive oil is found upon the market. The consumer has to depend for protection upon his knowledge of the character of the dealer and hereafter, to a greater extent than ever before, he may be protected by the application of the pure food laws of the various countries.

After the first pressing from which the best oil is secured the resulting pomace is removed from the press, heated or mixed with hot water, and again subjected to a much higher pressure from which a second quantity of oil is secured, still suitable for edible purposes but of a lower quality than that first produced. While the oils which are obtained in this way are used largely for technical purposes such as lubricating, soap making, etc., they are not infrequently employed as edible oils.

In the largest establishments for the preparation of olive oil the kernels are separated from the pulp, but in the smaller works the pulp and kernel are pressed together. Finally the residue from the second pressure may be dried and extracted with bisulfid of carbon or petroleum ether, by which means practically all the residual oil which the cake contains may be secured. Oils extracted in this manner are wholly unfit for edible purposes and are used or should be used solely for technical purposes, among which soap making is perhaps the most important.

Olive-kernel Oil.—An oil is extracted from the kernel of the olive which as regards some of its physical and chemical properties resembles olive oil itself. It is usually not considered suitable for edible purposes. Its taste resembles more that of almond oil than that of olive oil. Some of this oil is doubtless mixed with olive oil when the pulp and kernel of the olive are pressed together, but the quantity thus secured is not very great and does not introduce into the substance anything which gives a specific reaction. It is by no means as high a grade of oil as that expressed from the flesh of the olive alone.

Peanut Oil.—Peanut oil is the refined expressed oil of the peanut, prepared in the manner above described, and is highly valued as a table or salad oil and, unfortunately, is used very often as an adulterant of olive oil, the mixture being sold under the name of the more valuable of its constituents.

Peanut oil contains arachidic acid, which in combination with glycerine forms one of the constituents which serves to distinguish it particularly from other edible oils. There is no other edible oil which contains arachidic acid in sufficient quantities to lead to any mistake concerning its relationship to peanut oil.

Renard's Test for Peanut Oil as Modified by Tolman.—Place 20 grams of oil in an Erlenmeyer flask. Saponify with alcoholic potash, neutralize exactly with dilute acetic acid, using phenolphthalein as indicator, and wash into a 500 c.c. flask containing a boiling mixture of 100 c.c. of water and 120 c.c. of a 20 percent lead acetate solution. Boil for a minute, and then cool the precipitated soap by immersing the flask in water, occasionally giving it a whirling motion to cause the soap to stick to the sides of the flask. After the flask has cooled, the water and excess of lead can be poured off and the soap washed with cold water and with 90 percent (by volume) alcohol. Now add 200 c.c. of ether, cork the flask, and allow to stand for some time until the soap is disintegrated, then heat on the water bath, using a reflux condenser, and boil for about five minutes. In the oils most of the soap will be dissolved, while in lards, which contain so much stearin, part will be left undissolved. Cool the ether solution of soap down to from 15° to 17° C., and let stand until all the insoluble soaps have crystallized out—about twelve hours are required.

Filter and thoroughly wash the precipitate with ether. Save the filtrate for the determination of the iodin number of the liquid fatty acids by the Muter method. The soaps on the filter are washed back into the flask by means of a stream of hot water acidified with hydrochloric acid. Add an excess of dilute hydrochloric acid, partially fill the flask with hot water, and heat until fatty acids form a clear, oily layer. Fill the flask with hot water, allow the fatty acids to harden and separate from the precipitated lead chlorid; wash, drain, repeat washing with hot water, and dissolve the fatty acids in 100 c.c. of boiling 90 percent (by volume) alcohol. Cool down to 15° C., shaking thoroughly to aid crystallization. From 5 to 10 percent of peanut oil can be detected by this method, as it effects a complete separation of the soluble acid from the insoluble, which interferes with the crystallization of the arachidic acid. Filter, wash the precipitate twice with 10 c.c. of 90 percent (by volume) alcohol, and then with alcohol of 70 percent (by volume). Dissolve off the filter with boiling absolute alcohol, evaporate to dryness in a weighed dish, dry and weigh. Add to this weight 0.0025 gram for each 10 c.c. of 90 percent alcohol used in the crystallization and washing if done at 15° C.; if done at 20°, 0.0045 gram for each 10 c.c. The melting point of arachidic acid obtained in this way is between 71° and 72° C. Twenty times the weight of arachidic acid will give the approximate amount of peanut oil present. No examination for adulterants in olive oil is complete without making the test for peanut oil.

The above process can only be successfully carried out by an experienced chemist, and even then if only small quantities of peanut oil are present, namely, not to exceed five percent, the results obtained may not be exact.

Peanut oil is obtained from the peanut by the ordinary method of hydraulic pressure. The first cold pressing furnishes the oil of finest character for edible purposes. Subsequent pressure or pressure with heat furnishes a greater quantity of oil but of inferior palatability. Peanut oil is highly prized as a salad oil either alone or mixed with other oil, notably olive oil and sesamé. The oil is purified by settling followed by filtration and by the processes usually practiced with other oils of vegetable origin. The oil is easily and completely digested and furnishes an abundant source of heat and energy to the system. The number of calories produced by the combustion of one gram of oil, either by ordinary burning or by oxidation in the body, is about 9,300.

The cake which is left after the pressing out of the oil is very highly nutritious, containing still considerable quantities of oil, the whole of the protein matter, and other digestible solids of the nut.

As before stated, it is extensively used as cattle food and as fertilizer. It may also be ground to a meal and used as human food, but furnishes an unbalanced ration in which the protein is far in excess.

Rape Oil (Colza Oil) (*Brassica campestris* L.).—There are different kinds of oil which belong to the general class which is known as rape oil or rapeseed oil. The different kinds are derived from different varieties of *Brassica campestris*. The English names of the three most important varieties are—(1) colza oil, derived from the seeds of *Brassica campestris;* (2) rape oil, derived from the seeds of *Brassica napus* L.; (3) rübsen oil, derived from the seeds of *Brassica rapa* L. The character of the oil also varies according to the manner of its extraction. The first pressings from the cold powdered seeds is of a finer quality for salad purposes than the heavier later pressings from the hot seeds. The oil is also sometimes chilled and the crystallized stearin separated in order to keep it in a liquid state during the winter time, so that the winter and summer varieties are sometimes recognized in trade. There is, however, no difference in the other characteristics of the oil.

The specific gravity of rape oil at 15.5 degrees C., compared with water at the same temperature, is about .916. The variations from this mean number are not very great. Rapeseed oil absorbs almost its exact weight of iodin,—the average iodin number being not far from 99.

The Chief Adulterations of Rape Oil—The chief adulteration of rape oil consists in the admixture of cheaper or flavoring oils. Among those which are often used in the adulteration of rape oil are linseed oil, hempseed oil, poppyseed oil, chamomile oil, cottonseed oil, the various mustard oils, refined fish and blubber oils, rosin oil, and paraffin. Some of these adulterations, it is seen, cannot be added to rapeseed oil when used for edible purposes. The chief adulteration of rapeseed oil, when intended for edible purposes, is the addition of cottonseed oil. The detection of these various adulterations, with the exception of that of cottonseed oil, can be accomplished only by an expert chemist. The presence of cottonseed oil can be detected by the application of the Halphen test already described.

Technique of Extraction.—The extraction of oil from the rape seed is not different from that of other oily seeds. It is either extracted by pressure, which is the proper way always when it is to be used for edible purposes, or when used for technical purposes it may be extracted by means of carbon bisulfid or petroleum ether. When extracted by pressure for edible purposes the oil should be refined by a similar treatment to that applied to cottonseed oil and finally filtered, preferably after mixing with fuller's earth or other similar material, in order that it may be perfectly pure and bright and free from suspended matter which interferes with its utility as an edible oil.

A very common treatment of the expressed oil, in order to coagulate and separate the mucilaginous matter which it contains, is with sulfuric acid. This acid has the very valuable property of coagulating this class of bodies. When treated with sulfuric acid it is necessary that the oil be thoroughly washed many times in pure water in order to remove the last trace of the acid.

The residue or oil cake is prized as a cattle food or as a fertilizer. The average content of oil in rape seed is about 37 percent.

Sesamé Oil.—Sesamé oil is very commonly used for salad oil and for the other purposes to which the edible oils are devoted. It is also known as gingili oil and teel oil. Sesamé oil is obtained by pressure from the seed of the sesame plant,—*Sesamum orientale* L.

Sesamé oil possesses a light amber color when properly made, is free from any unpleasant odor, has an agreeable taste, and when expressed cold produces what is known as the cold-drawn oil which is regarded by many as of equal palatable value with olive oil. Sesamé oil, in addition to containing stearin, palmitin, and olein, also contains a small quantity of a glycerid which exists in large quantities in flaxseed oil, namely, linolein. When prepared for edible purposes it contains only a small quantity of free acid, is free from rancidity, clear, and brilliant in appearance and has a sweet agreeable taste. The specific gravity of sesamé oil at 15 degrees C. varies from .9225 to .9237. It absorbs from 103 to 108 percent of its weight of iodin and has a refractive index at 15 degrees of about 1.4748.

Adulteration of Sesamé Oil.—Some of the other vegetable oils are cheaper than sesamé and are added to it for the purpose of adulteration and cheapening the product. Among the most common oils used for the adulteration of sesamé are poppyseed oil, cottonseed oil, and rape oil. The presence of cottonseed oil in sesamé oil is easily distinguished by the Halphen test already given. The presence of poppyseed oil is revealed by the high iodin number and the high degree of heat produced when mixed with sulfuric acid.

Only the best variety of cold-drawn sesamé oil is used for edible purposes and for making oleomargarine. The inferior qualities are used in soap making, the making of perfumes, etc., and the lowest quality of oil is used for burning purposes.

Characteristic Reaction.—A test which is known as Baudouin's is extremely delicate and reliable and is easily applied. It consists in the development of a red color when a small quantity of sesamé oil is treated with hydrochloric acid in the presence of furfural. The test is easily carried out as follows: Place a few drops of a two percent solution of furfural in a test-tube with 10 cubic centimeters of sesamé oil or the oil to be tested for sesamé and 10 cubic centimeters of hydrochloric acid of 1.19 specific gravity, and shake the mixture well for half a minute. When the tube is left at rest, if sesamé oil be present the aqueous acid layer which forms will have a distinct crimson color. Any coloration which is produced by other oils is entirely distinct from this one and therefore can be easily distinguished.

Geographical Distribution.—The sesamé plant is grown chiefly for commercial purposes in India, China, Japan, and West Africa. The technical preparation of the oil, in so far as is known, is not practiced in the United States. It is pressed and prepared for commerce chiefly in France. The seeds are rich in oil, yielding a larger percentage by pressure or extraction than most of the oil-bearing seeds.

Sunflower Oil.—The oil extracted from the seed of the sunflower is of high quality for edible purposes. Although not in general use in this country, it is very extensively used in Russia and some other parts of Europe. There is every reason to believe that a profitable industry could be established in the preparation of edible oils from sunflower seeds. The plant grows in the greatest luxuriance in nearly all parts of the country, and the yield is sufficiently great to make it an object of more interest to our agricultural population than it is at the present time.

The oil is obtained from the seed of the sunflower (*Helianthus annuus* L.). It is of a pure amber tint with an agreeable odor and pleasant taste. As has already been said it is grown largely in Russia and also in Indo-China. The seeds are very rich in oil. Before expression the hulls should be removed, since these form a porous substance, and if the seeds are crushed with the hulls large quantities of oil are absorbed and cannot be recovered.

The method of preparation is the same as that for other edible oils, the kernel, after the removal of the hull, being ground and cold-pressed for the highest grade. By heating and renewing pressure lower grades of oil are secured suitable for soap making. Where all the oil is required the extraction with bisulfid of carbon or gasoline is advised. Such oils, however, are not suitable for edible purposes because of the difficulty of removing the last traces of the solvent. The specific gravity of sunflower oil at 15 degrees is approximately .925. It absorbs a very high percentage of iodin, and in this respect it may be classified with the drying oils. Its iodin number ranges from 120 to 130. No specific color reactions have been established by means of which sunflower oil may be readily distinguished from the other edible oils.

In fact sunflower oil has not been subjected, by any means, to as critical a study as many other vegetable oils.

Vegetable Fats.

The fatty principles in vegetables which are solid at ordinary temperatures are commonly termed fats instead of oils. They present, as a rule, a soft mass, usually of an amber tint and somewhat of the consistence of butter. Only a few of these solid fats or semi-solid fats are used for food. Among them the most important are palm-nut oil or coconut oil or fat, though the fat of the cacao also may be regarded as belonging to this group. These solid or semi-solid fats are used to a considerable extent for edible purposes in many parts of the world. Coconut fat and cacao fat are used very extensively in this country either in a pure state or in chocolate or cocoa.

Cacao Butter.—Cacao butter is the semi-solid fat obtained by pressure from cacao beans, the seeds of the cacao tree (*Theobroma cacao* L.). These beans are extremely rich in fat, the content of which varies from 35 to 50 percent. On a large scale the cacao beans are roasted, ground, and the fat expressed while still hot by hydraulic pressure. In order to remove the free acid which it contains the carbonates of the alkalies are mixed with the material after grinding and before extraction. In these cases the expressed fat naturally does not contain any free acid, though the soaps which are formed by this process are apt to contaminate the expressed fat.

Adulterations.—By reason of its high price cacao butter is often adulterated by the addition of various fats usually of a vegetable character. Those most generally employed are the stearin derived from the coconut fat and the palm-nut fat. The addition of ordinary edible vegetable oils is easily detected by the usual chemical tests and is especially recognized by the increase in the percentage of iodin absorbed. They also reduce the melting point of cacao butter, and for this reason these oils, with the exception of coconut, are not used very extensively as adulterants. Beeswax and paraffine wax are also used to some extent as adulterants, and when used in connection with vegetable oils they serve to keep the melting point from going too low. Tallow has also been used quite extensively as an adulterant. The detection of these adulterants is so difficult as to be accomplished only by a skilled chemist.

Composition.—Cacao butter is composed chiefly of stearin and palmitin, though other fats and oils are present in small quantities. Although it is generally supposed that cacao butter does not tend to become rancid, this is a mistake, since, when exposed to the conditions which favor rancidity, the fermentation which produces this condition takes place in the butter, though somewhat more slowly and more incompletely than in many other fats. The specific gravity of cacao butter at 50 degrees C. is .892. It absorbs about 35 percent of its weight of iodin. It has a much lower melting point than palm fats and even lower than butter. Its melting point varies from 30 to 33 degrees C. Cacao butter has some of the properties of ordinary butter and has been recommended as a substitute therefor, but it is not likely that it will ever come into common use both because it is less desirable than butter and also because of its high price.

Properties.—Cacao butter has a light amber tint and tends to become bleached on long standing. It has a very pleasant flavor, reminding one of the flavor of the preparations of chocolate. At ordinary temperature, 70 degrees F., it is quite solid and sometimes even brittle.

Coconut Oil or Butter.—This is a very abundant natural fat and is obtained from the kernel of the coconut, especially the two species *Cocos nucifera* L. and *Cocos butyracea* L. At ordinary temperatures coconut oil is of the consistency of fat. Its taste is pleasant, and it possesses an odor which is not disagreeable or undesirable. It differs from cacao butter in the ease with which it becomes rancid, at which time it takes on a very disagreeable flavor and taste. The coconut oil of commerce is distinguished by different names, according to the country in which it is made.

Cochin oil is a variety which is regarded as of the finest quality, being almost colorless, and is prepared in Malabar.

Ceylon oil is another very important variety made in the neighborhood of and imported from Ceylon. It is regarded as somewhat inferior to Cochin oil, due probably to less care being taken in the cultivation of the plant and the preparation of the oil.

Another variety of coconut oil is known as copra oil. The term "copra" is applied to the sun-dried or kiln-dried kernel of the coconut. In this dried state the fruit can be shipped in bulk and large quantities of it can be sent to Europe or other countries, where the oil is either obtained by extraction or by compression in a hydraulic press. This is regarded as of the least desirable quality.

Coconut oil resembles palm-nut oil in its chemical composition, with the exception of the relative proportion of palmitic acid. The specific gravity of coconut oil or fat at 40 degrees C. is about .912 and reduced to 15 degrees C. about .925. Coconut oil absorbs very little iodin, which is one of its principal characteristic chemical properties. The quantity of iodin absorbed may be taken as about eight percent of the weight of the oil. Coconut oil is one of the vegetable fats which resembles butter to some extent in the high content of volatile acid which it contains. If, under given conditions, butter may be regarded as having a volatile acid number of 27, coconut oil will have upon the same scale a volatile acid number of about 7, whereas ordinary vegetable oils and fats will have less than 0.5 on a similar scale. Coconut oil may be regarded as the one edible oil which approximates in constitution ordinary butter. Coconut oil has been used very extensively as an adulterant for oleomargarine, since by reason of its high volatile acid it brings that substance much nearer to the composition of butter or indicates a larger percentage of butter therein than is actually present. While it is used extensively as human food its principal value is for soap making. It appears as an edible fat under various names, such as "vegetable butter," "lactine," "nucoline," "palmin," etc. Coconut oil is also very extensively used in the manufacture of candies and confections.

Adulterations.—Coconut oil is rarely adulterated. About the only adulteration of any consequence is that of the admixture with palm-kernel oil, which has properties very much like that of coconut oil. These two oils are ordinarily about the same price and therefore there is no inducement to practice adulteration.

Palm Oil or Fat.—This oil is obtained from the fleshy part of the fruit of the palm tree *Elæis Guineensis* Jacq. and *Elæis melanococca* Gaertn. Extensive groves of these trees are found in Africa and also in the Philippines. In Africa they grow particularly upon the western coast. There is a large number of varieties of palm trees that afford this fat, but the two mentioned are the principal ones. This fat becomes solid at about the temperature of the body. It has a somewhat higher melting point than butter, which becomes liquid at a temperature of from 34 to 36 degrees C. When solidified the fat may be heated to 41 or 42 degrees before it again becomes liquid. Palm oil has rather a pleasant taste and is regarded as an edible fat of high quality, and is largely used as such by Europeans and in Africa and other countries where the fat is produced. The fat also has a very pleasant odor which is said to resemble somewhat that of violets. This pleasant odor is quite persistent and remains even in the fatty acids after they have been converted into soap. Palm oil is manufactured in the crudest possible way by the natives, and immense quantities are lost for this reason. By reason of this crude method, which leaves the oil in contact with the putrescible matter, palm oil often comes into the market in a rancid state or at least with a high content of free fatty acid. Appreciable quantities of water are also found in the crude article.

Inasmuch as the natural color of palm oil is somewhat too deep for the taste of the ordinary consumer, ranging from yellow to a dirty red color, it is often bleached in the refining process before being sent into commerce. Ordinary exposure to the air tends to bleach this oil, and ozone is also employed as a bleaching agent. The bichromate process of bleaching palm oil is very commonly practiced. By this method the oil is freed from its principal impurities and treated with from one to three percent of potassium bichromate and with hydrochloric acid which decomposes the "chrome" liquor, and in the chemical process which attends this reaction decided bleaching effects are produced. The bleaching agents are withdrawn and the oil thoroughly washed with water until all traces of chromate and mineral acid are removed.

Adulterations.—On account of its great cheapness and the fact that the admixture of other oils of lower melting point would detract from its value, palm oil has not been subjected to any extensive adulteration. The most common adulterations are the impurities which are left in the oil in the slovenly method of manufacture employed by the natives of Africa.

Constituents.—As would be expected from the name, one of the chief constituents of palm oil is palmitin. If palm oil is saponified and the solid separated from the liquid fatty acid, the former is found to consist almost exclusively of palmitic acid. The specific gravity of palm oil is taken at a high temperature, as much as 50 degrees C. or above. The specific gravity at this temperature is about .893. Palm oil absorbs a little over one half its weight of iodin. The average iodin number may be regarded as varying from 53 to 55. Aside from the limited use of palm oil for human food it is used chiefly in the manufacture of soap and of candles. It is also used extensively in the tin plate industry to spread over the hot iron surface to preserve it from oxidation until it is dipped into the bath of melted tin.

NUTS.

The Acorn.—Many varieties of acorns are used for human food. All of the nuts of the oak family are edible, but some of the larger and more common varieties contain such a quantity of tannin as to be rather bitter to the taste. The wild acorns were formerly utilized very extensively for the fattening of swine, producing an article of pork of high palatable value but with the production of a fat of a low melting point, unsuitable for the manufacture of lard for summer use. The term applied to the natural nuts eaten by swine for this purpose is "mast," and formerly "mast-fed" pork was an extensive article of commerce. The disappearance of the oak and beech forests, however, have practically eliminated this variety of pork from the markets, as far as commercial considerations are concerned.

Composition of the Acorn.—Edible portion, 64.4; refuse, 35.6.

	Edible Portion.
Water,	4.1 percent
Protein,	8.1 "
Fat,	37.4 "
Starch and sugar,	48.0 "
Ash,	2.4 "
Calories per pound,	2,718

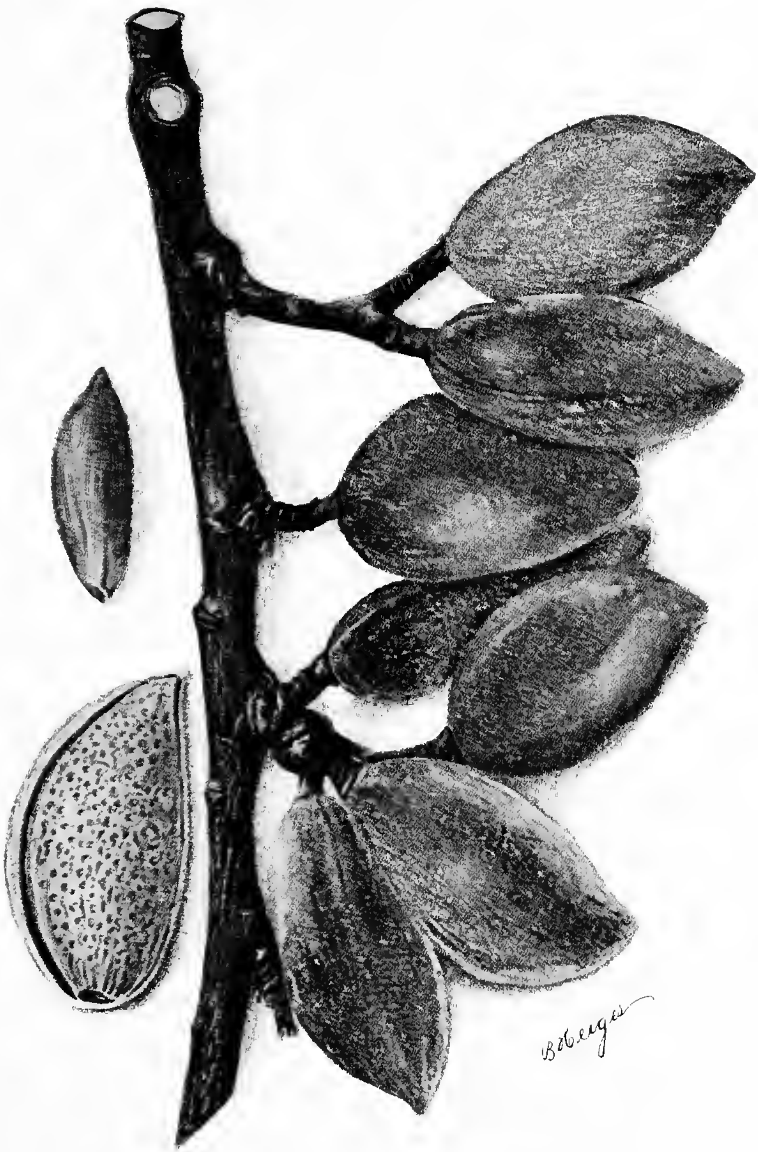
The acorn resembles the chestnut in its composition, containing more carbohydrates than fat. It is therefore not an oily seed, but one of a farinaceous character.

Almonds.—There are two species of almond trees, the *Amygdalus communis*, which is the common or sweet almond, and the *Amygdalus amara*, or the bitter almond which flourishes very extensively in the south of Europe. California has a climate which, with artificial irrigation, is favorable to the growth of the almond, and practically all that are produced in the United States for commercial purposes grow in that state. It is also cultivated extensively in France, Italy, and Spain, large supplies of the almonds of commerce coming from those localities. The almond is delicious when eaten in the green state, that is when the seed is fully formed but before the hull is hardened. It is rarely eaten in this condition in the United States, but forms a common article of diet upon the table of the Europeans in the early summer.

Composition of the Almond.—

Sample.	Water.	Protein.	Fat.	Total Carbohydrates.	Ash.
Edible portion:	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
California almonds,	4.8	21.0	54.9	17.3	2.0
European almonds,	6.0	23.5	53.0	14.4	3.1

In the United States the almond is eaten very extensively, often roasted and salted. In this condition it is found as a relish in many menus. The roasting improves to a certain extent the flavor of the nut, but the quantity of salt which is used is not always beneficial, inasmuch as an abundance of salt is eaten with other portions of the food. One of the most valued varieties is the Jordan almond, illustrated in the accompanying colored plate.



Jordan Almond

From Yearbook, U. S. Dept. of Agriculture, 1902

Beechnuts.—The beech tree is a very common forest tree throughout the northern part of the United States. Formerly immense areas in southern Ohio and Indiana were covered almost exclusively by the beech tree (*Fagus americana* Sweet). The beechnut is triangular in shape, resembling buckwheat, and formerly was produced in immense quantities over the region mentioned above. In the early days it was the principal food for swine. The hogs which are fattened by eating the beechnut and acorn produce a species of pork of a peculiar and very highly prized flavor. The celebrated hams and bacons of the southern Appalachian ranges were produced from the variety of hogs known as razor-backs fattened on mast, namely, the chestnut, beechnut, and acorn. The beechnut is also one of the principal winter foods of the squirrel and other animals which store their food for winter use. In the cutting of the forests in the winter often large stores of beechnuts are found stored away by squirrels and birds. The beechnut is not very abundant upon the markets of the country, but is eaten very largely by those who live in the vicinity of beech woods.

Composition of the Beechnut.—

SAMPLE.	REFUSE.	WATER.	PROTEIN.	FAT.	TOTAL CARBOHYDRATES.	ASH.	CALORIES.
Fagus Americana:	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Per pound*
Edible portion,	....	4.0	21.9	57.4	12.2	3.5	3,263
As purchased,	40.8	2.3	13.0	34.0	7.8	2.1	1,932
Fagus sylvestris:							
Edible portion,	....	9.1	21.7	42.4	22.9	3.9	....
As purchased,	33.0	6.1	14.5	28.4	15.4	2.6	....

Brazil-nut (*Bertholletia excelsa* Humb. and Bonpl.).—Large quantities of this nut are imported into the United States from Brazil and form an important article of food in many localities. This nut is not grown in the United States. It is also known as cream nut. The nut is triangular in shape and has a dark brown rough exterior. The kernel is highly flavored and quite oily. The tree is so sensitive to the cold that it will not grow successfully even in southern Florida, although many attempts have been made to introduce it into that locality.

Composition of the Brazil-nut.—Edible portion, 50.4; refuse, 49.6.

SAMPLE.	REFUSE.	WATER.	PROTEIN.	FAT.	TOTAL CARBOHYDRATES.	ASH.	CALORIES.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Per pound*
Edible portion,	....	5.3	17.0	66.8	7.0	3.9	3,329
As purchased,	49.6	2.7	8.6	33.6	3.5	2.0	1,678

Butternut (*Juglans cinerea* L.).—The butternut is another variety of walnut which grows very extensively in the United States and has the same geographical distribution as the walnut, except that the butternut is not so common west of the Mississippi. The tree does not grow so large as the walnut tree, nor is its wood so highly valued for commercial purposes. While the walnut is a round nut the butternut is very much elongated, forming an oval-shaped nut which is very highly valued as a food. The coloring matter of the butternut is practically the same as that of the walnut. The butternut also has a fleshy outer covering not so thick as that of the walnut and which is removed in the same way in the harvesting.

Composition of the Dry Butternut.—

	Edible Portion.	As Purchased.
Refuse,	....	86.4 percent
Water,	4.4 percent	.6 "
Protein,	27.9 "	3.8 "
Fat,	61.2 "	8.3 "
Sugar, etc.,	3.5 "	.5 "

The Chestnut (*Castanea dentata* (Marsh.) Bork).—The chestnut tree grows in great abundance wild in the United States, especially in the eastern portion on the foothills of the Alleghanies. In some localities it originally formed vast forests. The value of the timber and the fact that the chestnut grows only on good soil were prominent factors in the destruction of many of the original forests, especially those covering the arable lands. The trees still grow in great abundance, especially in the hilly regions.

In France the chestnut is very widely grown, and the nut is used very extensively as food by the poor classes. The nuts are often dried and ground to a flour which is mixed with water and baked in thin sheets, forming a very heavy but a sweet and nutritious cake. The chestnut is used in the preparation of many dishes, prized even by those who are well-to-do. In Italy the chestnut is also widely cultivated, and the nut is ground to form a kind of porridge known as polenta which is very extensively used as food. In the Apennines a cake made of chestnut flour and baked on hot stones is used under the name of necci. In Corea the chestnut is said to be a very common article of food, taking the place of the potato. It is eaten raw, boiled, roasted, or cooked with meats. The chestnut differs from the oily nuts in the smaller proportion of fat and the very much larger proportion of sugar and starch,—in fact, starch is almost missing in some of the oily nuts, the carbohydrates in the very oily ones being chiefly sugars. In the chestnut the starch is more abundant than the sugar, and for this reason the chestnut meal is more like the meal of the ordinary cereal than that of the oily seeds. The chestnut, also, as it is gathered fresh contains a great deal more water than the ordinary fresh seeds, the quantity ranging from 40 to 50 percent.

The average composition of the fresh chestnut, edible portion, is represented by the following data:

Water,	42.7	percent
Protein,	6.5	"
Fat,	6.3	"
Starch and sugar,	43.1	"
Ash,	1.4	"

The dried chestnuts, that is, those which have been kept for several months or which have been artificially dried, have a composition represented by the following data:

Water,	4.8	percent
Protein,	11.6	"
Fat,	15.3	"
Sugar and starch,	65.7	"
Ash,	2.6	"

The average weight of the hull of the chestnut is 15.9 percent of the total weight of the fresh nut, and 23.4 percent of the average weight of the dried nut. The above data are confirmatory of the statement that the meal of the chestnut in its composition is very much like that of the oily cereals, for instance, of Indian corn meal or oats. It, however, contains more oil and less protein than the cereals referred to. It is readily seen from the above data that chestnut meal may not properly take the place of Indian corn as human food. The nut of the chestnut tree ripens at the time of frost.

The wild chestnut shrub, which springs up in great numbers where the the original trees are cut away, is now extensively grafted with cultivated varieties. In Pennsylvania there are large orchards of the Paragon chestnut which have been grown in this manner.

Chinese Nut (*Nephelium litchi* Cambess.).—This is not a true nut in the ordinary sense of the word, but is usually classed with nuts. It is a product of China and is imported into the United States for consumption by our Chinese population. In the fresh state in China it has the reputation of being one of the best fruit products of that country, having flesh of a white color and a flavor resembling that of high-grade grapes; 41.6 percent of the fresh nut is refuse matter. The edible portion has the following composition:

Water,	17.9	percent
Protein,	2.9	"
Fat,	.2	"
Starch and sugar,	77.5	"
Ash,	1.5	"
Calories per pound,	1,453	

The above data show that in chemical composition the Chinese nut does not belong to the class of nuts at all. It is a fruit, its nutritive material being almost exclusively carbohydrates, while in the true nut the principal nutritive substances are the protein and the oil.

Coconut.—The coconuts which are consumed in the United States are mostly imported. It is estimated that three hundred thousand coconut trees (*Cocos nucifera* L.) have been planted in Florida, and from 15 to 20 percent of them are already bearing. The common name of the tree is the coconut palm. The fruit of the coconut palm is used for many purposes. The immature nuts are often used medicinally, forming the base of a valuable ointment for external use. The jelly which lines the shell of the more mature nut furnishes a food product of great delicacy and high nutritive value. The milk of the coconut is itself highly esteemed as a delicious article of food. Grated coconut is one of the basic constituents of that familiar condimental substance, East Indian curry. Coconut oil is a very highly edible fat from which a butter is made. The fat itself is valuable for cooking purposes. The composition of the coconut is shown in the following table:

SAMPLE.	REFUSE.	WATER.	PROTEIN.	FAT.	TOTAL CARBOHYDRATES.	ASH.	CALORIES.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Per pound*
Edible portion,	....	14.1	5.7	50.6	27.9	1.7	2,986
As purchased,	48.8	7.2	2.9	25.9	14.3	.9	1,529

The solid edible portion of the nut is highly oleaginous and contains also a considerable quantity of starch and sugar. Coconut milk is much poorer in nutrients than cow's milk, containing over 92 percent of water, only .4 percent of protein, and only 1.5 percent of fat. The carbohydrates contained therein are chiefly sugars.

Filberts.—The term filbert, according to some etymologists, is a corruption of the term "full beard," and is so named on account of its having many long beards or husks. The filbert is the fruit of the cultivated hazel tree (*Corylus avellana* L.). The nut contains a kernel having a pleasant taste and is quite oily and nutritious. It is not cultivated to any extent in this country where we rely principally upon the wild hazel for the hazelnut. The composition of the filbert is shown in the following table (edible portion, 47.9; refuse, 52.1):

	EDIBLE PORTION.
Water,	3.7 percent
Protein,	15.6 "
Fat,	65.3 "
Sugar and starch,	13.0 "
Ash,	2.4 "
Calories per pound,	3,432

The filbert is produced in large quantities on the Asiatic shore of the Black Sea. The region of Trebizond is the most prolific source of the filbert.

Hazelnut.—The hazelnut grows on a small tree or large shrub (*Corylus avellana* L.). The species which grows wild in the United States is known chiefly as *Corylus america* Walt. It is from this shrub that the common wild hazelnut is obtained. There is also another variety grown in this country, *Corylus rostrata* Ait. The hazelnut is a small, nutritious, and palatable nut of a brown color and grows over a very large area of the United States, especially in the northern part of the country. It is quite an article of commerce, but is not cultivated to any great extent. The cultivated variety, as has already been stated, is known as the filbert.

Composition of the Hazelnut.—

SAMPLE.	REFUSE.	WATER.	PROTEIN.	FAT.	TOTAL CARBOHYDRATES.	ASH.	CALORIES.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Per pound*
Edible portion,	....	3.7	15.6	65.3	13.0	2.4	3,432
As purchased,	52.1	1.8	7.5	31.3	6.2	1.1	1,644

Hickory-nut.—The hickory-nut is another one of the nuts which sometimes is classed with walnuts and grows wild very extensively throughout the United States, having the same geological distribution as the walnut and butternut. The hickory tree (*Hicoria ovata* (Mill.) Britton) produces a nut of highest quality. On account of the character of the bark, which becomes detached and often widely separated from the trunk, it is known as the shagbark or shellbark hickory.

Another variety of the hickory tree is known as the pignut (*Carya glabra*). The nut produced by this tree is much less prized than the other hickories, often containing a sufficient amount of tannin to make it distinctly bitter. The wood of the hickory is very tough and elastic and is used extensively in the manufacture of spokes for wagon-wheels, axe-handles, etc. The young hickory trees grow thickly together and have a slender reed-like growth. They are used extensively in the manufacture of hoop-poles. The hickory has suffered from the advance of the farmer much in the same manner as the walnut and other valuable timber trees. The original trees have almost entirely disappeared. The young trees grow vigorously and in a few years will bear nuts, and in some localities the care and cultivation of the wild tree has been established for the purpose of securing new forests of nut-bearing trees. The hickory-nut is even more highly prized for eating purposes than the butternut and walnut, but should be eaten under the same conditions, namely, before the passing of the first winter after their production. They, also, on account of their high content of oil, tend to become rancid when they are kept through the warm summer.

Composition of the Dry Hickory-nut.—Edible portion, 37.8; refuse, 62.2.

	EDIBLE PORTION.	
Water,	3.7	percent
Protein,	15.4	"
Fat,	67.4	"
Sugar and starch,	11.4	"
Ash,	2.1	"
Calories per pound,	3,495	

Peanuts.—The peanut is a widely cultivated plant. It grows extensively in the United States, and is especially regarded as a crop of high value in North Carolina and Virginia. Very large quantities of peanuts are grown in Senegal, in Algiers, in Egypt, and in many other localities.

The pod containing the seed grows underground, but is not a part of the roots, properly so-called. The pods are attached by slender stems to the stalk of the peanut, and may be regarded as the seed of the plant, entering and maturing underground. When embedded they are soon covered by a soft envelop and then by several similar coverings. For edible purposes they are much improved by roasting, which gives them an aromatic, nutty flavor that is much liked. A striking illustration of the plant showing the seed-pods is given in the accompanying colored plate.

Peanuts are used as food both directly, as after roasting, and indirectly, by the expression of oil, which after proper refining is considered of high value for edible purposes. The oil of the peanut forms an edible oil of rich flavor, pleasant taste, and high nutritive value. It is used, either alone or mixed with other edible oils, notably with olive oil for table purposes and for the making of salad dressing. The residue of the pressings for peanut oil are highly valued as a cattle food, containing large quantities of nitrogenous nutriment, and also as a manure.

The composition of the peanut varies greatly in different localities. Its chief value as a food material lies in the high percentage of protein it contains and the high percentage of fat. The composition of the typical hulled peanut is shown in the following table:

Water,	9.2	percent
Protein,	25.8	"
Fat or oil,	38.6	"
Sugar, starch, etc.,	24.4	"
Insoluble cellulose,	2.5	"
Ash,	0.9	"

Only the blossoms which form on the lower part of the stalk produce the fruit, since it is necessary that the long stem should strike the earth and the young fruit penetrate to the depth of from five to six centimeters in order that the fruit may mature. This method of penetrating the earth is shown very well in the colored figure already mentioned.

PEANUT (ARICHIDE)

From Huileries Calve-Delft (Holland)

The original home of the peanut is not definitely known, but is supposed to be Africa. It was first described as occurring on the American continent by Ferdinand de Oviedo in San Domingo in the beginning of the 16th century. It is now very generally distributed in all the tropical countries in South America, Asia, and Africa, and, as before described, grows very well as far north as the northern boundary of North Carolina and in southern Virginia. Peanuts are used for food in all the countries mentioned with previous preparation and roasting.

The above data show that the peanut is a food product extremely rich in oil and protein and comparatively poor in carbohydrates. For dietetic purposes it should be eaten with some highly amylaceous substance, such as potato, rice, or tapioca.

The value of the peanut for food purposes is not fully realized in this country, where it is eaten rather as a relish and as an incident to the circus or the picnic. In such cases they are usually consumed in too large quantities and by unbalancing the ration may produce unpleasant effects from which an unreasonable prejudice against this valuable food product might arise.

Peanut Butter.—An oily preparation of the peanut or the oil therefrom deprived of a part of its stearin is known as peanut butter and is used as a substitute for ordinary butter. What has been said of the nutritive value of the oil of the peanut applies also to this product. The butter has the peculiar flavor of the peanut which is not agreeable to some persons, but is considered extremely palatable by others. The nuts are also powdered more or less finely and mixed with other food products. Peanuts which grow in northern Senegambia are regarded very highly for the manufacture of fine salad oil, and peanut oil is used extensively for this purpose.

Peanut Butter and Peanolia.—Peanut butter and peanolia are used to a considerable extent in the United States as food products. They are prepared from peanuts, properly roasted, ground to a fine powder, and mixed with an appropriate quantity of salt. The analyses of the samples of these products, made in the Connecticut Agricultural Experiment Station, show the following composition:

	Peanut Butter.	Peanolia.
Water,	2.10	1.98
Protein,	28.66	29.94
Fat,	46.41	46.68
Sugar and dextrin,	6.13	5.63
Starch,	6.15	5.58
Insoluble cellulose,	2.30	2.10
Common salt,	3.23	4.95
Ash,	.80	1.08

The above analyses show that the preparations are produced from the roasted peanuts, which process reduces the water to about 2 percent. The ground, roasted product is mixed with about 4 percent of common salt. The other constituents are the same as those of the peanuts from which the preparations were made. Of the carbohydrate content of the peanut about 4 percent has been found to be pentosans.

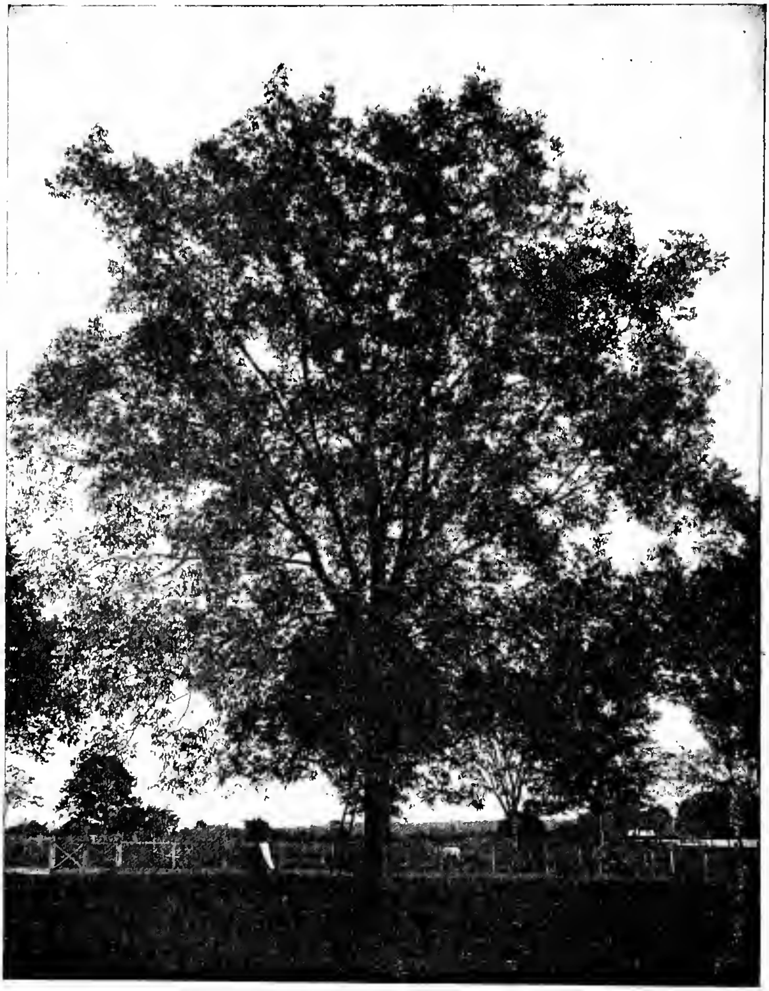


FIG. 58.—PECAN TREE, 30 YEARS OLD, MORGAN CITY, LA.—(*Courtesy of H. E. Van Deman.*)

Where Peanuts are Grown.—Virginia is one of the most important of the peanut-growing states, especially in its southeastern portion. The Commissioner of Agriculture of Virginia reports that about one hundred thousand acres are planted annually in the state of Virginia, producing over four million bushels. Fifty bushels per acre is considered a good average yield. An important point in the production of good peanuts is the selection of the

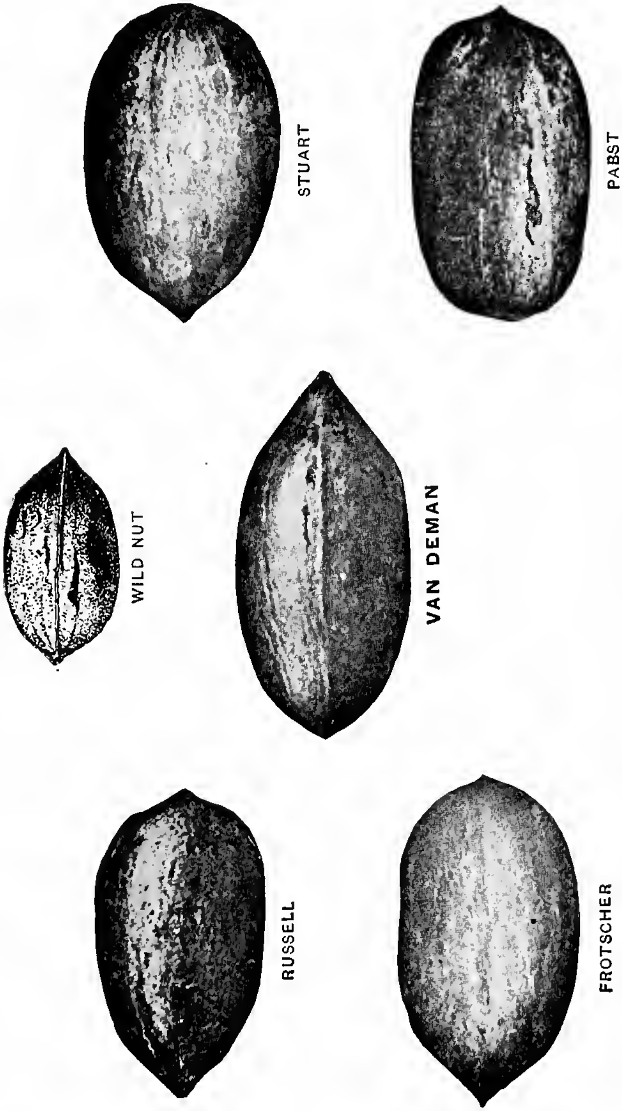


Fig. 59.—Five Forms of Choice, Thin-shelled Pecans. Also Wild Nut Showing Difference in Size.—(*By permission American Nut and Fruit Co.*)

seeds. The most vigorous and well formed kernels are to be selected for planting, and especially those that are produced by plants of identical size and shape. By a selection of this kind the quality of the crop can be greatly improved.

One of the peculiarities of the peanut is that it is an underground legume. All other leguminous fruits mature above the soil. Its underground habitat is the reason for its botanical name, hypogæa. If the stem carrying the small, yellow, butterfly-shaped flowers, which springs from the axis of the branch above the ground, fails to reach the soil no fruit is formed. If the soil is properly cultivated the germ may penetrate of its own accord. However, art assists nature in this matter and covers up the pods so as to give them a better start. The peanut, like some other leguminous crops, develops nodules upon its roots in which the bacteria that assimilate free nitrogen live in symbiotic union with the plant itself.

Pecan-nut (*Hicoria pecan* (Marsh.) Britton; *Carya olivæformis* Nuttall).—The pecan is a nut which is very much valued and grows, with a most excellent flavor, in the southern part of the United States. Texas, Louisiana, southern Alabama, Mississippi, Georgia, and Florida are the principal regions where the pecan grows, although it is cultivated in some instances much further north.

The pecan belongs to the same family as the hickory-nut and is indigenous to the United States. It grows wild over a large area, extending from southern Illinois and Indiana to the Gulf. It often forms very large trees in the forests. There are several species of *Hicoria*. The fruit of the pecan is especially valued on account of the thinness of the shell and its extremely pleasant and aromatic flavor. As is the case with most nuts, it is composed chiefly of oil and proteids, the sugar and starch being in minute proportions. The composition of the fruit of the pecan, when divested of its hard shell, is given in the following table:

	Edible Portion.	
Water,	2.9	percent
Protein,	10.3	"
Fat,	70.8	"
Sugar, starch, etc.,	14.3	"
Ash,	1.7	"
Calories per pound,	3,445	

For marketing purposes the pecans are now largely grown in orchards, as the supply of the wild nut is uncertain, and its texture and flavor are not so fine as the cultivated variety. The cultivated variety may also be grafted upon the wild tree with good effects. The tree begins to bear at four or five years of age. A comparative appearance of the wild and cultivated nut is shown in the accompanying Fig. 59. The tree, when full grown, is handsome in appearance, and is valued as a shade tree as well as a fruit producer. The full grown tree is shown in the accompanying Figs. 58 and 60.

Pine-nuts.—In many portions of the western part of our country pine-nuts are consumed largely as food. There are several species of pines yielding edible nuts on the Pacific coast of the United States and as far east as Colorado and New Mexico. These nuts are articles of considerable impor-

FIG. 60.—FULL GROWN PECAN TREE.—(*By permission Field Columbian Museum.*)

tance in the commerce of many of the cities of California. The principal specimens of pine which yield edible nuts are *Pinus monophylla* Torr. and Frem., *Pinus edulis* Engelm., *Pinus sabiniana* Dougl. The refuse is usually less than 50 percent of the total weight of the nut.

Composition of the Edible Portion.—

Botanical Name.	Water.	Protein.	Fat.	Starch and Sugar.	Ash.	Calories per Pound.
Pinus monophylla,	3.8	6.5	60.7	26.2	2.8	3,327
" edulis,	3.4	14.6	61.9	17.3	2.8	3,364
" sabiniana,	5.1	28.1	53.7	8.4	4.7	3,161

Pistachio.—The nut of the pistachio (*Pistachia vera*) is used very largely for flavoring purposes and also for food. The tree is a native of Syria but has been cultivated in southern Europe for many years. The nut produced in America, though larger than the native Syrian fruit, is not considered so palatable. The pistachio is also grown to some extent in the southern part of the United States as well as in California. The kernel of the fruit is green in color and has a flavor which in some respects is reminiscent of almonds. It is used chiefly in this country in the manufacture of confectionery and ice creams.

Composition of the Pistachio.—

	Edible Portion.	
Water,	4.2	percent
Protein,	22.3	"
Fat,	54.	"
Starch and sugar,	16.3	"
Ash,	3.2	"
Calories per pound,	3,235	

Walnuts (*Juglans nigra* L.).—The American walnut grows wild over a very large portion of the country, especially the middle section west of Maryland to the Mississippi river. The walnut tree is especially abundant along the Ohio river, where it forms in the early summer a dense foliage. The trees often attain a very great size, reaching a diameter as great as five feet.

The walnut trees grow only on rich soil, hence, unless the country was very hilly and unsuitable for cultivation, the walnut forests were the first to fall before the axe of the pioneer. Later the demand for walnut lumber completed the devastation of the walnut forests, until now very often in the regions where fifty years ago the trees were extremely abundant a large walnut tree is rarely seen. The walnut lumber has peculiar lasting powers, and on account of its natural color and grain is of the highest value for building and ornamental purposes. The early farmers in the Ohio valley made their rail fences out of walnut trees. The wild nut grows in a dense kernel and is covered with a thick pericarp which is green even at the time when the fruit is ripe. After a frost when the fruit naturally falls from the trees the outer covering disintegrates. When the nuts are gathered by boys the outer covering is usually beaten off with clubs. It contains a coloring matter of a brown or brownish black tint which the early housewives used for dying homespun cloth. The bark of the tree also contains to a greater or less extent the same coloring matter. The kernel of the walnut, that is, the edible portion, is extremely rich in oil and protein and has a very pleasant taste. Like other nuts the walnut is best during its first winter, since on longer keeping the oil tends to become rancid and the fruit unpalatable.

White Walnut (*Juglans regia* L.).—The white walnut, commonly known as the English walnut, is grown very extensively in France. All the departments of south central and southeastern France grow these walnuts as a valued crop. The best walnut orchards are at an altitude of from 600 to 900 feet. Only the outer or exposed limbs produce perfect nuts. In planting the most important precaution is to give the trees plenty of room, 15 yards is about the usual distance at which they are planted. The trees are cultivated and fertilized with manure and commercial fertilizers every two or three years. A bearing orchard of these white walnuts in France is worth from four to five hundred dollars per acre and may yield a revenue of from seventy-five to one hundred dollars a year per acre. The nuts ripen from the middle of September to the end of October. These nuts are used largely in America as a food, for which purpose the kernels are carefully extracted in halves, commonly known as "walnut halves." In France an excellent table oil is expressed from the dry nut which for many culinary purposes is valued as highly as olive oil. After extraction the oil cake is used for stock food. The white walnut is supposed to have been originally introduced from Persia, though it is commonly known as the English walnut. In the United States the butternut tree is commonly known as the white walnut.

The composition of the kernel of the dry walnut is shown by the following data:

Edible portion:

Water,	2.5	percent
Protein,	16.6	"
Fat,	63.4	"
Total carbohydrates,	16.1	"
Ash,	1.4	"

As purchased:

Refuse,	58.1	percent
Water,	1.0	"
Protein,	7.0	"
Fat,	26.6	"
Total carbohydrates,	6.7	"
Ash,	.6	"

General Discussion.—A brief description has been given above of the principal edible nuts used in the United States, accompanied by a statement of their chemical composition. The character of these food products is well shown by the analytical data. Nuts as a whole are extremely oily substances and contain next in importance as a food material, protein. Alone they constitute an unbalanced ration in which the fat and protein are abundantly present at the expense of the starch and sugar. For this reason an exclusively nut diet cannot be recommended, as it surely tends to unbalance the ratio and to disturb the digestion in the great majority of cases. There are doubtless individuals of a peculiar temperament who can thrive on a diet of nuts alone, but such a case is exceptional. On the other hand the value of the nut as a food is undeniable, both as a nutrient and as a pleasant condimental addition to the food. The large percentage of oil in nuts also in many cases is beneficial from the well-known effect of oil in promoting the digestive activities, mechanical and otherwise. Nuts should be eaten in as fresh a state as possible, especially those of a highly oily character. Rancidity not only spoils the taste but interferes largely with their dietetic value. On account of the high amount of oil, nuts are preëminently a heat-forming food and thus can be eaten very freely by those engaged in vigorous bodily exercise and during cold weather. They also form a food especially useful during periods of extreme exertion, since by their combustion they furnish abundant stores of heat and energy.

Many fads relating to foods flourish in various localities. Among them the school of dietetics, which advises a diet solely of nuts, is worthy of mention. It is true that life can be sustained for an indefinite time on a diet of nuts alone. If the nuts are sought in the forests and fields the good effects of the exercise and outdoor life are to be taken into consideration. There is no reason to believe, however, that the general condition of mankind, from a dietetic point of view, would be improved by an exclusive nut diet. The impossibility of supplying man with such a food product is also a factor in the discussion of the problem that should not be forgotten.

Food Fads Self-limiting.—Nearly all the vagaries relating to diet are self-corrective. Should the human family suddenly adopt as a sole diet any of the articles so enthusiastically advertised by their partisans, these articles would at once so increase in price as to be beyond the reach of all but the very rich. The choice for the masses would then be between the adherence to a theory or starvation. That many people would willingly starve for devotion to a principle is well attested by historical facts. But few would be found to keep the faith. We are, therefore, content to receive the good which most of these theories contain and feel no concern as to ultimate injury to the race.

It is a matter of surprise, however, to find that the greater the vagary in a food fad the more extensive the vogue. The appeal of the extreme to the human imagination seems at times quite irresistible. Sooner or later, however, the errant knight returns to reason and common sense.

PART VIII.

FUNGI AS FOODS.

Mushrooms.—Certain fungi growing wild or in cultivated soils and having an expanded top on a hooded stem are known as mushrooms. The common form of mushroom (*Agaricus campestris* L.) grows wild over a large portion of the United States. It is especially abundant in the autumn, growing sometimes during the night after a warm rain, over large areas. When properly cooked it forms a delicious food and condimental substance, highly prized by connoisseurs and others. Belonging to the family of mushrooms, however, are many poisonous varieties which, when eaten inadvertently, often cause serious illness and sometimes death. For this reason mushrooms sold in the open market should be carefully inspected by experts authorized to see that the poisonous varieties are excluded. It not only requires a good botanist, but also one skilled in the practical differentiation of the different varieties by physical appearance rather than by botanical analysis, to properly separate the poisonous from the edible varieties.

Historical.—Mushrooms have been, since historical times, extensively used as human food. In a book written five centuries before the Christian era, Athenée, in his "Banquet of Learned Men," speaks of the poisoning of a mother and her three children by mushrooms. Hippocrates speaks of a girl who had been poisoned by mushrooms and who was cured by the administration of hot honey and by a hot bath. Theophrastes and Nicandre also speak of mushrooms and the poisoning that occurs therefrom. Both Cicero and Horace make reference to mushrooms. Horace advises that Epicureans should confine themselves to the mushrooms that grow upon meadows and refuse to eat all others on account of the danger from poisoning. Ovid also makes frequent allusions to mushrooms and speaks of the influence of warm rains upon their growth. Tacitus refers to the use of mushrooms for food, and Suétonius, in his "History of the Twelve Cæsars," relates that the Emperor Claudius was poisoned by a dish of mushrooms. It is, therefore, evident that from the earliest times mushrooms were extensively used and the poisonous properties of some of the varieties understood.

Production of Mushrooms.—As has already been mentioned, mushrooms grow wild over a large area of the United States. They are also cultivated very extensively, though not to so great an extent as in European countries.

The best place for growing cultivated mushrooms is one where the light is excluded or diffused and where the temperature remains reasonably constant. Cellars, caves, and the artificial caverns made by quarrying are peculiarly well suited for the growth of different varieties of fungi, such as mushrooms. They grow well in some localities in uncovered beds.

The art of growing mushrooms is not easily acquired. The directions given by the best authorities may be rigidly followed and failure ensue. The skill of the grower appears to be largely intuitive and those who have it succeed where theoretical knowledge fails. For cultural purposes, the *Agaricus campestris* is most universally employed.

Soil.—The soil best suited for the growth of mushrooms is one rich in decayed or decaying vegetable matter. Mushrooms are often found growing in localities where a log or stump has decayed or where the inorganic matter from the manure of cattle or horses has been distributed on the soil. Artificial beds for the growth of mushrooms are made up largely of organic manurial substances.

Spores.—Mushrooms are grown from spores. The mushroom produces a brown powdery material which consists of almost innumerable simple cells of ovate shape to which the term "spore" has been applied. A spore is not in the strict sense of the word a seed, but simply a cell which by proliferation produces the new fungus. Generally growers do not use these spores directly in seeding mushroom beds. Each complete spore, however, is, under favorable conditions, capable of proliferation or germination, producing a thread-like growth of a spider-web character which penetrates through the soil, prepared and manured, upon which a spore is germinated. This spider-web-like growth, in the common language of mushroom growers, is called the spawn, more properly called the mycelium of the mushroom. When the conditions are favorable, there are formed on the threads of this mycelium small nodules, which are the earlier stages of the complete fungus itself. From the beginning of this growth until the final production of the mushroom two or three days or even a week may elapse. The earlier periods of this growth take place under ordinary circumstances, but the advent of a warm rain or other extremely favorable conditions causes the budding mushroom to grow at an enormously rapid rate. The mushroom may not be said to have a root, stem, and leaf, as is the case with an ordinary green plant, but is practically a single organism, assuming different shapes which are represented by the different varieties and species of growth.

Differing Varieties of Edible Mushrooms.—There is a very large variety of edible mushrooms differing in form, size, and shape from the *Agaricus campestris*. In the Washington markets there are four principal kinds of mushrooms which are found growing wild in the vicinity of the city. These comprise the common mushroom—*Agaricus campestris*, the horse mushroom—

Agaricus arvensis, shaggy mushroom—*Coprinus comatus*, and the puff-ball—*Lycoperdon cyathiforme.*

Conditions of Growth.—The proper shed or cellars having been selected, the first thing to do is to see that the temperature is favorable to the growth of the fungi. Temperatures above 60 degrees F., or below 50 degrees F., are not favorable to the growth. The best temperatures are from 55 to 58 degrees. The locality where the mushrooms are grown should be kept very damp and the air highly saturated with aqueous vapor. The reason that mushrooms grow best in covered places, such as has been mentioned, is due to the particularly favorable influence which the even temperature mentioned and a practically saturated atmosphere have upon the growth. In localities where the changes of temperature are not very severe, mushrooms grow very well in the open. In the county of Kent, England, I have seen mushrooms growing in the open garden, where, by covering with straw, they flourish during the greater part of the year. In the winter time the temperature may be kept quite even by the covering so as to yield abundant crops, while in the months of August, September, and October they grow in the open in great abundance.

Preparation of Seed Bed.—The seed bed for the growth of mushrooms, as has already been indicated, is made principally of well decayed stable or stall manure. The manure must be well fermented, thoroughly disintegrated, and exposed for a sufficient length of time to be in the proper condition. Mushrooms cannot be obtained until the heat attending the fermentation of manure has entirely disappeared.

Directions for growing mushrooms cannot be given here, but those who are intending to enter the business should consult the best authorities and begin in a small way until they acquire the necessary skill before commercial success can be obtained.

Growth of Mushrooms in France.—Perhaps in no country has the cultivation of mushrooms been carried to such a large extent as in France. The principal industries in France are confined to those regions where artificial caves have been made by the quarrying of building stone. The most extensive caverns of this kind exist in the neighborhood of Paris, near Bordeaux, and particularly in the neighborhood of Sceaux. These artificial caverns are often miles in extent and furnish exceptionally favorable opportunities for the growth of mushrooms. The soils or manures on which they are grown must be carried into these caverns, and experience has shown that mushrooms do not continue to grow well in the same locality, and, therefore, the place of growth must be moved from time to time to different parts of the caves. The galleries of these abandoned quarries are sometimes of enormous extent and are from 30 to 150 feet below the surface. They are generally from seven to ten feet high, but occasionally so low that a man cannot stand upright in them. In general they are wide enough for two rows of beds with a foot way 18 inches wide in the center. Where a mushroom bed has been well prepared and properly seeded, it produces about six pounds of mushrooms per square yard. These mushrooms bring, in the market, an average of about 15 cents per pound. It is stated by some authorities that the reason the bed ceases to bear after a time and has to be abandoned or moved is not because of the exhaustion of the food but is due to the ravages of an insect or fly which produces a worm which is fatal to the growth of the fungus. At any rate, it is customary to abandon the beds after they have been bearing for six or eight months and to return to them after a year, when they are found to again be productive.

It is not expected that the general consumer will become an expert in the selection of mushrooms. Where mushrooms are exposed in a public market, it is the duty of the municipal officers in charge of food products to see to it that poisonous varieties are not exposed for sale. It will be of value, however, to the reader to have some idea of the general shape of some of the more common edible and poisonous varieties. It is generally supposed that mushrooms, toadstools, and puff-balls are entirely distinct species and that only the mushroom, so-called, is edible. On the contrary, there are many edible toadstools and many edible puff-balls, and all three classes of fungi belong to the same general family.

Food Value of Mushrooms.—The nutritive value of mushrooms is not exceptionally high, although there is a popular opinion to the contrary. Frequently it has been stated that the mushroom in the vegetable world holds a similar position to beefsteak among meats, being particularly rich in digestible protein. The analytical data which have been collected from numerous sources on the composition of mushrooms do not bear out this popular impression, but, on the contrary, show that the mushroom is a food product consisting very largely of water and of only very small quantities of protein, fat, and carbohydrates.

The composition of some of the common mushrooms is shown in the following table (Farmers' Bulletin, No. 79, Mushrooms as Food):

Kind.	Water.	Total Nitrogen.	Albuminoid Nitrogen.	Non-albuminoid Nitrogen.	Protein.	Fat.	Carbohydrates.	Fiber.	Ash.
Common mushroom, ...	91.30	0.60	0.36	0.24	3.75	0.20	3.50	0.80	0.50
Shaggy Coprinus, ...	92.19	.45	.15	.30	2.81	.26	1.40	.57	.98
Inky Coprinus, ...	92.31	.36	..	..	2.25	.24	....	.72	1.29
Common Morel, ...	89.54	.49	.37	.12	3.06	.50	1.60	.91	1.08

These data may be compared with the composition of the beefsteak:

Water,	62.5	percent
Protein,	19.5	"
Fat,	17.0	"
Ash,	1.0	"

From the above data it is seen that the mushroom does not contain anything like the amount of protein found in beefsteak. It has one-third more water, one-sixth as much protein, and only one-fortieth as much fat. Beefsteak contains no carbohydrates except less than one percent of glycogen, while the amount of carbohydrates in the mushroom varies from 1.5 to 3.5 percent. It is evident that the mushroom is principally valuable as a condimental substance and not as a food product.

Distinction between Poisonous and Edible Varieties.—It has already been stated that only the expert is able to distinguish between the poisonous varieties of mushrooms and those that are edible. Even the skilled botanist, as well as the expert, may sometimes make mistakes in this matter. Hence the only perfectly sure method of protection against the poisonous varieties is the eating of only those which are cultivated and which are known to be free of poisonous properties. On the other hand, the wild variety, by many connoisseurs, is much more highly valued as being more delicate and palatable. It should also be remembered that the cultivation of mushrooms is not very widely extended, and if the supply of the wild variety should be excluded there would be a great diminution of the quantity which is accessible to the consumer. This would be an especial hardship in the United States, where mushrooms grow wild over such wide areas and so abundantly and where the cultivation of them as compared with some other countries is somewhat restricted. There are some general characteristics by means of which a distinction can be made between the edible and the poisonous varieties.

The following rules are given for the rejection of the probably poisonous mushroom by George Francis Atkinson ("Studies of American Fungi—1900"): "In the selection of mushrooms to eat, great caution should be employed by those who are not reasonably familiar with the means of determination of the species, or those who have not an intimate acquaintance with certain forms. Rarely should the beginner be encouraged to eat them upon his own determination. It is best at first to consult someone who knows or to send first specimens away for determination, though in many cases a careful comparison of the plant with the figures and descriptions given in this book will enable a novice to recognize it. In taking up a species for the first time it would be well to experiment cautiously."

No Certain Rule to Distinguish the Poisonous from the Edible.—"There is no test like the 'silver-spoon test' which will enable one to tell the poisonous mushroom from the edible ones. Nor is the presence of the so-called 'death-cup' a sure sign that the fungus is poisonous, for *Amanita cæsarea* has this cup. For the beginner, however, there are certain general rules, which, if carefully followed, will enable him to avoid the poisonous ones, while at the same time necessarily excluding many edible ones.

"1st.—Reject all fungi which have begun to decay, or which are infested with larvæ.

"2d.—Reject all fungi when in the button stage, since the characters are not yet shown which enable one to distinguish the genera and species. Buttons in pasture lands which are at the surface of the ground, and not deep-seated in the soil, would very likely not belong to any of the very poisonous kinds.

"3d.—Reject all fungi which have a cup or sac-like envelope at the base of the stem, or which have a scaly or closely fitting layer at the base of the stem and rather loose warts on the pileus, especially if the gills are white. *Amanita cæsarea*, however, has a sac-like envelope at the base of the stem and yellow gills as well as a yellow cap, and is edible. *Amanita rubescens* has remnants of a scaly envelope on the base of the stem and loose warts on the cap, and the flesh, where wounded, becomes reddish. It is edible.

"4th.—Reject all fungi with a milky juice unless the juice is reddish. Several species with copious white milk, sweet or mild to the taste, are edible.

"5th.—Reject very brittle fungi with gills nearly all of equal length where the flesh of the cap is thin, especially those with bright caps.

"6th.—Reject all Boleti in which the flesh changes color where bruised or cut, or those in which the tubes have reddish mouths, also those the taste of which is bitter. *Strobilomyces strobilaceus* (Scop.) Berk. changes color when cut, and is edible.

"7th.—Reject fungi which have a cobwebby veil or ring when young, and those with slimy caps and clay-colored spores.

"In addition, proceed cautiously in all cases, and make it a point to become very familiar with a few species first, and gradually extend the range of species rather than attempt the first season to eat a large number of different kinds. All puff-balls are edible so long as they are white inside, though some are better than others. All coral-like or club fungi are edible."

Popular Distinction between Toadstools and Mushrooms.—There is a general opinion that the toadstool is poisonous and the mushroom is not. There is, however, no scientific distinction between the two kinds of fungi, popularly known as toadstools and mushrooms. The distinction is purely an arbitrary one. The small toadstools are often as delicious and as harmless as the small mushroom. The small mushroom, on the other hand, may be as deadly and as undesirable as the worst specimen of toadstool. There is danger especially to two classes of people in the discrimination between the poisonous and edible varieties of mushrooms and toadstools. The first class is composed of those who are practically unaware of the existence of poisonous varieties and the second class of persons are those who claim to be able to tell an edible mushroom from a certain number of tests or claims which they regard as infallible. Both of these classes of persons are apt to be deceived or injured by dangerous varieties.

The following popular signs of distinguishing between the poisonous and non-poisonous varieties are pronounced worthless by Gibson ("Our Edible Toadstools and Mushrooms and How to Distinguish Them"):

"FAVORABLE SIGNS.

1. Pleasant taste and odor.

2. Peeling of the skin of the cap from rim to center.

3. Pink gills, turning brown in older specimens.

4. The stem easily pulled out of the cap and inserted in it like a parasol handle.

5. Solid stems.

6. Must be gathered in the morning.

7. 'Any fungus having a pleasant taste and odor, being found similarly agreeable after being plainly broiled without the least seasoning is perfectly safe.'

"UNFAVORABLE SIGNS.

8. Boiling with a 'silver spoon,' the staining of the silver indicating danger.

9. Change of color in the fraction of the fresh mushroom.

10. Slimy or sticky on the top.

11. Having the stems at their sides.

12. Growing in clusters.

13. Found in dark, damp places.

14. Growing on wood, decayed logs, or stumps.

15. Growing on or near manure.

16. Having bright colors.

17. Containing milky juice.

18. Having the gill plates of even length.

19. Melting into black fluid.

20. Biting the tongue or having a bitter or nauseating taste.

21. Changing color by immersion in salt-water, or upon being dusted with salt.

"These present but a selection of the more prevalent notions. Taken *in toto*, they would prove entirely safe, as they would practically exclude every species of toadstool or mushroom that grows. But as a rule the village oracle bases his infallibitity upon two or three of the above 'rules,' and inasmuch as the entire list absolutely *omits* the *only* one test by which danger is to be avoided, it is a seven days' wonder that the grewsome toadstool epitaph is not more frequent."

The following tests are regarded as favorable by Gibson:

1. Avoid every mushroom having a *cup* or *suggestion* of such, at base; the distinctly fatal poisons are thus excluded.

2. Exclude those having an unpleasant odor, a peppery, bitter, or other unpalatable flavor, or tough consistency.

3. Exclude those infested with worms or in advanced age or decay.

4. In testing others which will pass the above probation let the specimen be kept by itself, not in contact with or enclosed in the same basket with other species.

Begin by a mere nibble, the size of a pea, and gentle mastication, being careful to swallow no saliva, and finally expelling all from the mouth. If no noticeable results follow, the next trial, with the interval of a day, with the same quantity may permit of a swallow of a little of the juice, the fragments of the fungus expelled as before. No unpleasantness following for twenty-four hours, the third trial may permit of a similar entire fragment being swallowed, all of these experiments to be made on an empty stomach. If this introduction of the actual substance of the fungus into the stomach is succeeded by no disturbance in twenty-four hours, a larger piece, the size of a hazelnut, may be attempted, and thus the amount gradually increased day by day until the demonstration of edibility, or at least harmlessness, is complete and the species thus admitted into the "safe" list. By following this method with the utmost caution the experimenter can at best suffer but a slight temporary indisposition as the result of his hardihood, in the event of a noxious species having been encountered, and will at least thus have the satisfaction of discovery of an enemy if not a friend.

It may be said that any mushroom, *omitting the Amanita*, which is pleasant to the taste and otherwise agreeable as to odor and texture when raw, is probably harmless and may safely be thus ventured on with a view of establishing its edibility. A prominent author on our edible mushrooms (McIlvaine) applies this rule to all the Agarics with confidence. "This rule may be established," he says: "All Agarics—excepting the Amanitæ—mild to the taste when raw, if they commend themselves in other ways, are edible." This claim is borne out in his experience, with the result that he now numbers over one hundred species among his habitual edible list out of the three hundred which he has actually found by personal test to be edible or harmless. "So numerous are toadstools," he continues, "and so well does a study of them define their habits and habitats, that the writer *never fails upon any day from April to December to find ample supply of healthy, nutritious, delicate toadstools for himself and family.*"

"In gathering mushrooms one should be supplied with a sharp knife. The mushrooms should be carefully cut off an inch or so below the cap, or at least sufficiently far above the ground to escape all signs of dirt on the stems. They should then be laid gills upward in their receptacle, and it is well to have a special basket, arranged with one or two removable bottoms or horizontal partitions, which are kept in place by upright props within, thus relieving the lower layers of mushrooms from the weight of those above them. Such a basket is almost indispensible.

"Before preparing mushrooms for the table, the specimens should be carefully scrutinized for a class of fungus specialists which we have not taken into account, and which have probably anticipated us. The mushroom is proverbial for its rapid development, but nature has not allowed it thus to escape the usual penalties of lush vegetation, as witness this swarming, squirming host, minute grubs, which occasionally honey-comb or hollow its entire substance ere it has reached its prime; indeed, in many cases, even before it has fully expanded or even protruded above ground.

"Like the carrion flies, the bees, and wasps, which in early times were believed to be of spontaneous origin—flies being generated from putrefaction, bees from dead bulls, and the martial wasps from defunct "war-horses"—these fungus swarms, which so speedily reduce a fair specimen of a mushroom to a melting loathsome mass, were also supposed to be the natural progeny of the 'poisonous toadstool.' But science has solved the riddle of their mysterious omnipresence among the fungi, each particular swarm of grubs being the witness of a former visit of a maternal parent insect, which has sought the budding fungus in its haunts often before it has fully revealed itself to human gaze, and implanted within its substance her hundred or more eggs. To the uneducated eye these larvæ all appear similar, but the specialist in entomology readily distinguishes between them as the young of this or that species of fly, gnat, or beetle.

"As an illustration of the assiduity with which the history of these tiny scavenger insects has been followed by science, I may mention that in the gnat group alone over seven hundred species have been discovered and scientifically described, many of them requiring a powerful magnifier to reveal their identities.

"Specimens of infected or decaying mushrooms preserved within a tightly closed box—and, we would suggest, duly quarantined—will at length reveal the imago forms of the voracious larvæ; generally a swarm of tiny gnats or flies, with an occasional sprinkling of small glossy black beetles, or perhaps a beautiful indigo-blue insect half an inch in length of most nervous habit, and possessed of a long and very active tail. This insect is an example of the curious group of rove-beetles—staphylinus—a family of insect scavengers, many of whose species depend upon the fungi for subsistence.

"Even the large woody growth known as 'punk' or 'touchwood,' so frequently seen upon decaying trunks, is not spared. A huge specimen in my keeping was literally reduced to dust by a single species of beetle.

"Considering the prevalence of these fungus hosts, it is well in all mushrooms to take the precaution of making a vertical section through stem and cap, excluding such specimens as are conspicuously monopolized, and not being too critical of the rest, for the over-fastidious gourmet will often thus have little to show for his morning walk. I have gathered a hundred specimens of fungi in one stroll, perhaps not a quarter of which, upon careful scrutiny, though fair of exterior would be fit for the table. The fungus hunter *par excellence* has usually been there before us and left his mark—a mere fine brown streak or tunnel, perhaps winding through the pulp or stem, where his minute fungoid identity is even yet secreted. But we bigger fungus eaters gradually learn to accept him—if not too outrageously promiscuous—as a natural part and parcel of our Hachis aux Champignons, or our simple mushrooms on toast, even as we wink at the similar lively accessories which sophisticate our delectable raisins, prunes, and figs, to say nothing of prime old Rochefort" (pages 33-34).

E. Faupin, the author of the work "Les Champignons Comestibles et Vénéneux," gives some valuable hints respecting the confusion of edible and poisonous varieties of mushrooms. He also says that the so-called rules which are often formulated to distinguish the good mushrooms from the bad are nearly all misleading. If they are applicable in a few particular cases they surely are not in all, and consequently ought to be judged as of no value. For instance, it has been commonly said that the mushrooms whose flesh changes color when exposed are poisonous. This is true for certain kinds but it is not true for others. There are, indeed, some mushrooms whose flesh undergoes an alteration when it is exposed and which are, nevertheless, of most excellent quality. As an example of this, the variety known as "delicious lactaire" may be cited. On the contrary there are other kinds whose flesh remains white on exposure and which are decidedly poisonous, as for example *Amanita citrina* Pers. It is also said that a mushroom whose stem is surrounded by a ring is to be considered edible. This indication is altogether deceptive. Some of the most poisonous varieties have well formed rings. It is also misleading to credit the action of the juice of the mushroom in coloring a piece of silver. It is said that those mushrooms whose juice blackens silver are poisonous, while those which do not are harmless. This perhaps is the most dangerous of all the rules to go by, as some of the most poisonous varieties would be admitted on this test. It is also misleading to suppose, as is commonly the case, that mushrooms which are attacked by insects, larvæ, etc., can be eaten without danger. Likewise misleading is the general opinion that mushrooms whose odor is agreeable or which have no appreciable odor are not poisonous. It is high time to eradicate these misleading notions and to let the people know with certainty that aside from the botanical character there does not exist any particular sign nor any particular means of affirming that a given mushroom is edible or poisonous. Science alone, therefore, has the sole power of teaching to distinguish the poisonous from the non-poisonous varieties. For many years attempts have been made to popularize the science which will give to the people the desired information, but in spite of these efforts the number of cases of poisoning does not seem to diminish, and why? The response is evident. It is because the efforts which have been made by mycologists have not yet been appreciated by the mass of people, and because it has not yet been possible to point out to the public at large the poisonous species. The number of species of poisonous mushrooms which are capable of causing death is happily not very great. The *Amanitas* and the *Volvarias* are almost exclusively the poisonous species. Let it be understood, therefore, by the people that there do exist mushrooms which are capable of killing. If the people desire to place themselves out of danger let them begin by learning these varieties. Their number is very limited, as there are only five or six species at most. When they are well known it will be very easy to distinguish them and to recognize all others as edible. Following is a list of the most poisonous mushrooms known, and all that are likely at any time to produce death:

Amanita phalloides Fr.
" citrina Pers.
" verna Bull.
" virosa Fr.
Volvaria gloiocephala, var. speciosa (Fr.).
Amanita muscaria (L.) Pers.
" pantherina DC.
Lactarius torminosus (Schaeff.) Fr.
" rufus Fr.
" zonarius (Bull.) Fr.
" pyrogalus (Bull.) Fr.
Russula emetica Fr.
" queletii Fr.
" fœtens (Pers.) Fr.
Boletus felleus Bull.
" satanus Lenz.
" erythropus Cke.
" luridus Schaeff.
Entoloma lividum Bull.

The Most Poisonous of Mushrooms.—The most poisonous of the common mushrooms is known as *Amanita verna* Bull. So active is its poison that this variety has become known as the "deadly Amanita."

Types of Edible Mushrooms.—While it is quite impossible for a manual of this kind to give any directions by which a person, not an expert, may make certain distinctions between the edible and poisonous varieties of mushrooms, it is thought advisable to give a fair technical illustration of the two classes. The common mushroom, *Agaricus campestris*, is shown in the accompanying Fig. 61,—three-fourths its natural size. The second specimen from the left is young and is in a state of development known as a button. The figure at the extreme left is a larger specimen, showing the slightly checked surface that sometimes occurs in this species. In fresh specimens the surface is white, but various shades of light brown, either checked or plain, are often found. The specimen at the right shows the gills on the lower surface of

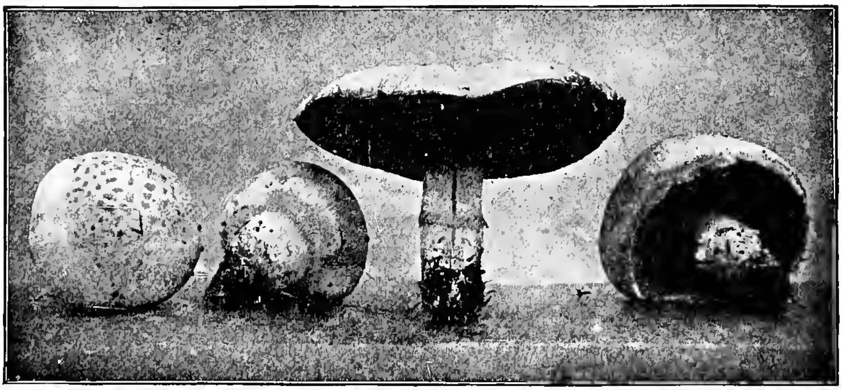


FIG. 61.—COMMON MUSHROOM, *Agaricus campestris*. EDIBLE. (THREE-FOURTHS NATURAL SIZE.) —(*F. V. Coville, Circular No. 13, Division of Botany, Department of Agriculture.*)

the cap. These gills in a newly expanded mushroom, fresh from the field, are of a beautiful delicate pale pink color, often with a touch of salmon. In the older samples the gills turn to a light brown and finally almost to a black color. This discoloration is chiefly due to the development of almost innumerable spores from which new plants are propagated. If the stem of a common mushroom be broken off and the cap be laid gills downward on a piece of white paper, the spores will drop off and after a few hours will appear as a brown dust. The usual diameter of full-grown specimens of this variety of mushroom is from $1\frac{1}{2}$ to 3 inches, though many smaller and many larger samples are found.

This variety of mushroom is the principal one which is exposed upon the markets of Washington. They are especially abundant in the autumn after copious rains often succeeding the usual period of drought in that region.

October is the banner month for this variety of mushroom. The mycelium from which the autumn mushroom grows is formed in the spring, and after the dry period of summer the little spheroid granules formed upon the mycelium are capable of absorbing the moisture of the warm autumnal rains and rapidly expand to the full-grown mushroom. After all the conditions of growth are fulfilled it usually requires only a single night for a button to push through the surface of the soil and expand its cap. Mushrooms are particularly obnoxious to the ravages of insects, and it is always advisable that they should be gathered and eaten immediately after they are formed. The insect larvæ attack the mature mushroom, travelling up through the stem into the cap, and decomposition rapidly follows.

It is easy to determine whether a mushroom is wormy or not by breaking

FIG. 62.—EDIBLE MUSHROOMS (*Agaricus arvensis* Schaeff.).—(*F. V. Coville.*)

off the stem close to the cap and observing if there are little holes through which the larvæ have passed upward into the cap. The common mushroom occurs most frequently on lawns and in pastures, and especially in neglected fields where weeds have been succeeded by a scant covering of grass. Sometimes during the spring and summer, as well as in the autumn, the common mushroom is found upon the market. These mushrooms usually are produced upon the garbage dumping grounds near the city. The garbage and refuse from the city furnish the manurial conditions required for a speedy development of the mushroom from the mycelium.

The Horse Mushroom (*Agaricus arvensis* Schaeff.).—This variety of mushroom is also one which grows in great abundance in the neighborhood of Washington and in other latitudes affording a similar environment. This specimen is in many respects like *Agaricus campestris* but the surface of the cap is somewhat darker colored. The ring on the stem is also wider and thicker than in *campestris*. This variety also grows larger than *campestris*, and the diameter of the cap is commonly from three to six inches.

FIG. 63.—SHAGGY MUSHROOM, *Coprinus comatus*. EDIBLE. (THREE-FOURTHS NATURAL SIZE.)—(*Coville, Circular 13, Division of Botany.*)

The figure is only about one-half the natural size. The horse mushroom is frequently confounded with the common mushroom, and there is practically no difference in their edible qualities. It grows preferably in gardens rather than fields, and especially in gardens which have been heavily fertilized. It also frequently appears in old beds composed of decayed stable manure which has been used for forcing beds for early vegetables.

Shaggy Mushroom (*Coprinus comatus* Fr.).—The accompanying Fig. 63 represents a group of three specimens of this variety of mushroom growing from a single base. The largest one is already showing signs of liquefaction and decomposition and a part of the cap has partially disappeared. One of the peculiarities of this species is that beginning with the edge of the cap the whole mushroom dissolves sometimes within a day, when it is full grown, into an inky-black fluid. A portion of this inky fluid has run partly down the white stem of the largest mushroom. The cap of this mushroom, except when it begins to liquefy, resembles somewhat the form of a partially closed umbrella. In the early stages of growth the cap, gills, and stem are white, except the apex of the cap, which is generally dark-colored. The surface of the cap is covered with delicate lacerated scales, the characteristic from which the name *comatus* or shaggy is derived. The juice from the fresh sample is colorless as water. When it first begins to turn it is wine-colored, and until the juice is very deeply discolored the sample is still edible. After the juice has turned completely black it is considered too old to be eaten. This species of mushroom grows best in shady places, in a soil well supplied with humus. The season in which this variety of mushroom is most abundant is late in the autumn or early in the winter, when the nights are cold but the ground is not yet frozen. The liquefaction and decay of this mushroom come on so quickly that it is not usually infested with larvæ which do not have time to develop before the mushroom is reduced to a shapeless mass. The most common organism found is the myriapod, a thousand-legged worm, which often finds its way between the gills and stem. This cavity should always be examined for worms of this kind when the mushroom is being prepared for the table.

Fairy Ring Mushroom (*Marasmius oreades* Fr.).—This variety is one which is interesting both on account of its edible properties and by reason of the circular areas which it encloses and around which it often forms a symmetrical border. The tendency of this variety to grow in the annular form designated is beautifully shown in the accompanying figure, from a photograph taken on the grounds of the Department of Agriculture. The ring in question is seven feet in diameter and the photograph was taken early in November. The stem in this variety has no ring,—the gills are few and widely separated and the cap as it becomes fully expanded has a peculiar knob-like projection in the center. This gives a characteristic appearance to this variety of mushroom. The cap and stem are colored a pinkish-buff, and the gills have a lighter shade of the same color varying in early growth toward a cream tint. The spores are white and can be observed by placing the cap, as already indicated, on a dark-colored paper, preferably black glazed paper. The fairy ring mushroom is one of the commonest species which grows on the lawns in Washington and vicinity. As many as twenty of these fairy rings have been found on the grounds of the Department of Agriculture in one season. In the earlier days, when superstition was more rife than at present, these rings were supposed to mark the places of the dances of the fairies. Another fanciful cause assigned for the production of the rings was that it was due to the effect of lightning striking the ground and burning the grass in a circle, and thus favoring the growth of fungi. Investigations, however, show that the fairy ring is due to a peculiar way in which the mycelium is produced, *i. e.*, beginning at a central point

FIG. 64.—FAIRY RING FORMED BY *Marasmius oreades*, AN EDIBLE MUSHROOM.—(*Coville, Circular 13, Division of Botany.*)

and growing uniformly in all directions a few inches a year. After a while the central portion, being older, begins to die, and thus a small circular band is formed which each year increases in size, growing regularly on the outside and dying as regularly on the inside. The fairy rings are not always complete circles,—they are sometimes broken and often are crescent-shaped. This variety of mushroom is quite permanent, does not tend to decay as rapidly as some, and resists better than most varieties the attacks of insects. They, however, are very small as compared with the other common varieties.

Puff-balls.—A typical mushroom known as the puff-ball is the variety known as *Lycoperdon cyathiforme* Bosc. The puff-ball is so plain in its form that a description of its appearance is difficult. Usually the outside is colored brown and the covering is more or less irregularly checked, the white color of the interior showing between the darker, elevated areas. When still quite young the flesh is solid, of a milk-white color, and apparently quite dry. After two or three days it becomes soft, has a yellow tint, and acquires a watery and later an amber-colored juice as it continues its development through to the later stages. If the mushroom remains ungathered, the interior dries up into a fine brown powder which is projected into the air when pressed by the finger. It is often blown away by the wind. When the fungus reaches this stage of decay it is very commonly known as "the devil's

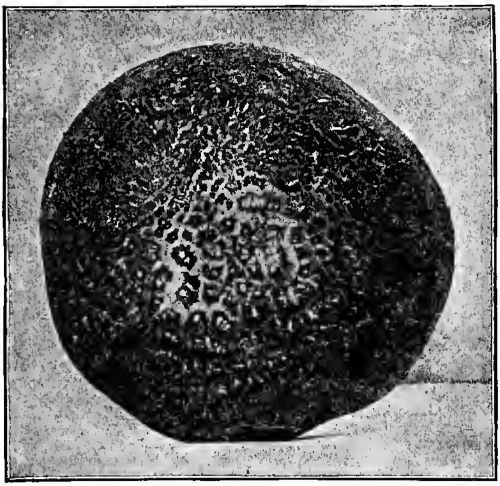


FIG. 65.—PUFF-BALL, *Lycoperdon cyathiforme*, TOP VIEW. EDIBLE. (THREE-FOURTHS NATURAL SIZE.)—(*Coville, Circular 13, Division of Botany.*)

snuff-box." Finally the spores and other dust-like bodies are blown away, and there is left only a dry and leathery framework. In the latter stages the puff-ball is not regarded as edible, not because of its being poisonous, but on account of its dry and leathery consistency. In the neighborhood of Washington puff-balls are found commonly in the autumn on lawns and in gardens, and especially on vacant lots where the soil has remained uncultivated and been closely grazed by cattle. The puff-ball also tends to grow in a fairy ring form, and in the circular area in which it grows the grass is likely to be darker in color, showing the existence of a richer soil. It is only while the interior of the puff-ball is still solid and white, with something like the texture of cheese, that it has its highest edible value.

Cepe (*Boletus edulis* Bull.).—This variety of mushroom is one of the most highly esteemed, especially in the south of France. It is large and has a very large, half-pear shaped stem. The flesh of this variety of mushroom is white and quite firm in the young mushroom, but becomes softer with age and assumes on the outside a wine tint. It grows, especially in the late summer and through the autumn, wild in the forest. In the extreme south of France it sometimes appears as early as April. ("Nouvel Atlas de Champignon," Paul Dumée, page 45.) ("The Mushroom Book," by Nina L. Marshall, page 109.) The cap is usually from four to six inches in diameter and is a gray, brownish-red or tawny-brown in color.

FIG. 66.—AMANITA (FULL-GROWN). (ONE-HALF NATURAL SIZE.)—(*Coville, Circular 13, Division of Botany.*)

The Fly Amanita (*Amanita muscaria* (L.) Fr.).—This is one of the very poisonous varieties of mushrooms. In the illustration the fully matured mushroom is shown at one-half its natural size. This is the most common poisonous mushroom which grows in the District of Columbia and other nearby localities. The points especially to be noticed are the bulbous enlargement at the base of the stem, breaking into thick scales above, the very broad drooping ring near the top of the stem, and the corky particles loosely attached to the smooth, glossy upper surface of the cap. The stem, gills, and the spores are white, the corky particles commonly of a buff color, but sometimes varying almost to white. The glossy upper surface of the cap, beneath the corky particles, varies from a brilliant red to orange-yellow, buff, and even white. Commonly in the vicinity of Washington the coloration is orange in the center, shading to yellow toward the margin. Brilliant red ones are rarely seen in this locality, but white ones are not infrequent, especially late in the season. This was the variety of mushroom that lately caused the death of a well known man in Washington. This poisonous variety is one of the largest, handsomest, and most

FIG. 67.—FLY AMANITA BUTTONS (*Amanita muscaria*). (NATURAL SIZE.)

dangerous of mushrooms, and is one whose poisonous character has been most fully studied. It is abundant in the vicinity of Washington in the fall, growing chiefly in the pine woods and, especially, in the localities which have been frequented by hogs. The chief active poisonous principle of the *fly amanita* is an alkaloid called muscarine, but other poisonous substances whose exact nature has not yet been discovered also occur in the plant.

When this variety of mushroom is reduced to a paste and exposed where it can be eaten by flies the latter are readily poisoned, and hence the common name of "*fly amanita.*"

Symptoms of Mushroom Poisoning.—The symptoms of poisoning from the *fly amanita*, as deduced from a number of cases, are varied. In some instances they begin only after several hours, but usually in from one-half to one or two hours. Vomiting and diarrhea almost always occur, with a pronounced flow of saliva, suppression of the urine, and various cerebral phenomena, beginning with giddiness, loss of confidence in one's ability to make ordinary movements, and derangement of vision. This is succeeded by stupor, cold sweats, and a very marked weakening of the heart's action. In case of rapid recovery the stupor is short and usually marked with mild delirium. In fatal cases the stupor continues from one to two or three days, and death at last ensues from the gradual weakening and final stoppage of the heart's action.

Treatment for Poisoning.—The treatment for poisoning by *Amanita muscaria* consists primarily in removing the unabsorbed portion of the *Amanita* from the alimentary canal and in counteracting the effect of the muscarine on the heart. The action of this organ should be fortified at once by the subcutaneous injection, by a physician, of atropin, in doses of from one one-hundredth to one-fiftieth of a grain. The strongest emetics, such as tartarized antimony or apomorphin, should be used, though in case of profound stupor even these may not produce the desired action. Freshly ignited charcoal or two grains of a one percent alkaline solution of permanganate of potash may then be administered in order, in the case of the former substance, to absorb the poison, or in case of the latter, to decompose it. This should be followed by oils and oleaginous purgatives, and the intestines should be cleaned and washed out with an enema of warm water and turpentine.

Experiments on animals poisoned by the *fly amanita* and with pure muscarine show very clearly that when the heart has nearly ceased to beat it may be stimulated to strong action almost instantly by the use of atropin. Its use as thus demonstrated has been the means of saving numerous lives. We have in this alkaloid an almost perfect physiological antidote for muscarine, and therefore in such cases of poisoning its use should be pushed as heroically as the symptoms of the case will warrant.

The presence of phallin in *Amanita muscaria* is possible and its effects should be looked for in the red color of the blood serum discharged from the intestines. (Circular 13, Div. of Botany.)

Removal of the Poisonous Principle.—In some parts of Europe the *fly amanita* is soaked in vinegar and then is eaten with impunity. Some of the colored people in Washington and vicinity are acquainted with this method of treatment, and the practice of soaking these fungi in vinegar and then eating them is not unknown, though the majority of colored women in the markets who deal in mushrooms look upon this species with unrestrained horror.

The poisonous variety is denatured as follows: The stem is well scraped, and the gills are removed from the cap and the upper surface peeled off. The mushrooms prepared in this way are boiled in salt and water and afterward steeped in vinegar. They are finally washed in clear water and then cooked in the ordinary manner and eaten without any injurious results. It is not recommended, however, that a mushroom which contains so much deadly poison should be eaten at all, even after a preparation of this kind. Any carelessness in the preparation or any failure to carry out the process completely would result fatally.

Canned Mushrooms.—The canning of mushrooms is an industry of large magnitude, especially in France. The young, unexpanded mushrooms in the form of buttons are those which are usually subjected to the canning process. Mushrooms are brought to the factory where they are cleaned and scraped, the stem cut to a proper length, thoroughly washed in several washings of clean water, and taken to a sulfuring furnace where they are exposed to the fumes of burning sulfur for some time. The purpose of this treatment is to bleach the mushroom and make it as white as possible. Decayed or deformed buttons are not included in the cans of highest quality. The prepared mushrooms are then placed in cans, usually of tin, and preserved by subjecting them to a temperature at or above boiling water until thoroughly sterilized. Mushrooms are also preserved by desiccation.

Canned Pieces and Stems of Mushrooms.—The imperfect portions, the pieces which are cut away, and other fragments of the mushroom, resulting from the preparation of the product described above, are treated practically in the same manner for sterilizing purposes and are sold to the trade under various names, the most common of which is Champignons d'Hotel. They also frequently appear under the name of Champignon Choix and other deceptive labels.

Adulteration of Mushrooms.—There is no adulteration practiced of fresh mushrooms unless the occasional occurrence of poisonous varieties may be so considered. It is evident, however, that the introduction of poisonous varieties is the result of carelessness or mistake and not for any purpose. Nevertheless a most exacting supervision over the preparation of fresh mushrooms for the market should be required, and any failure to exercise this care may be considered as resulting in adulteration or depreciation of the character of the product.

In canned mushrooms the presence of sulfurous acid may be regarded as an adulterant, and such a substance, believed to be inimical to health, is not necessary in the preparation of the goods. It is quite certain that the public taste would soon adapt itself to an amber- or brown-colored product in canned mushrooms and value it as highly as the buttons which are white. Since the sole purpose of the use of sulfur is for bleaching, the end secured scarcely justifies the means. It is claimed, naturally, that the use of sulfur is also a safeguard in securing a better keeping of the product, but such an adjunct for keeping purposes is only necessary when the sterilization is not complete. It is to be hoped that the day will soon come when mushrooms bleached with sulfurous acid shall no longer be found upon our market. The use of other preservatives than sulfurous acid has at times been practiced, but it is not believed that there are many cans of mushrooms offered upon the market which contain any chemical preservatives whatever save the sulfurous acid above noted. Since the canned mushrooms are valued principally as a condiment, the inclusion of imperfect or partially decayed or malformed buttons is extremely unusual. The buttons are separated into sizes of approximately the same magnitude, so that a can of the product is uniform in size as well as in quality. The customer may be reasonably certain that he is getting a good, young, carefully selected product, free from disease and from accidental impurities which might render the product unwholesome or unpalatable.

Truffles.—The truffle has been known almost, if not quite as long as the mushroom as an edible delicacy. The use of truffles in France became very common during the 14th century, but on account of their high price they remained for a long time a luxury and not a general article of commerce. It is only within the 19th century, after 1840, that their consumption became general. The truffle belongs to the botanical family Tuberaceæ.

The propagation of truffles is similar to that of mushrooms, by spores, which first give rise to a mycelium which furnishes the nutrients for the tubercle during a certain time of its early growth. In the cultivation of the truffle, artificially, it is necessary to make use of a forest or some similar artificial covering. If trees are planted especially for the development of truffles it requires six or eight years growth before the cultivation of truffles is successful. The truffle grows very readily in the shade of nut-bearing trees and in the shade of the oak. The mycelium does not produce truffles until after several years of vegetation. When it once begins to fructify and produce the truffle it continues to bear for many years. The truffle, like the mushroom, grows rapidly. At first, as has already been stated, it is nourished by the mycelium, but when this is exhausted it is nourished by absorbing the nutritious elements from the soil and air. When it reaches maturity and its spores are well formed the truffle acquires its maximum of aroma and palatability. After it has reached maturity it can remain a certain time in the soil without being changed. However, after a time it is rapidly decomposed and its tissues become the seat of various chemical reactions or it is devoured by insects.

Cultivation of Truffles.—The truffle may only be grown in the midst of very favorable conditions of climate, altitude, mellowness of the soil, moisture, and proper shade. The planting of truffle trees serves as a *vehicle* for the spores which are later to give birth to the mycelium which itself produces the truffle. The spores of the truffles usually reach the forests in which they are grown by natural means without being particularly planted. Sometimes, however, the spores are carried directly to the soil where the new crop is to be grown.

Geographic Distribution.—The truffle, like the mushroom, is spread over all parts of the earth. In Europe it is especially abundant in France and Italy. The provinces in France where it grows in greatest abundance are Provence, Dauphiné, Languedoc, and Périgord.

Principal Varieties.—The varieties of truffles are not so numerous as mushrooms, of which perhaps a thousand different varieties are known, but still they are sufficiently numerous. One of those frequently cultivated in France is known as truffles of Périgord (*Tuber melanosporum* Vittad.). It grows best under the shade of a growing walnut or a young oak. The tubers of these plants, which are the part valuable for food, may weigh from 60 to 500 grams. Other botanical varieties which are much cultivated are *Tuber brumale* Vittad., *Tuber æstivum* Mich., *Tuber magnatum* Vittad., and many others.

Harvesting of Truffles.—The truffle comes into production from the sixth to the tenth year after planting the appropriate forest trees. It is easy to determine the year when the harvest should begin, since during the preceding year there is found in the soil some hypogæan mushrooms which may be considered as precursors of the truffles. Moreover, the soil under the tree becomes practically free of all vegetation. The truffle ripens from November to April, according to its variety. It is important that it should not be harvested except at the period of complete maturity. For harvesting purposes certain animals are made use of, such as the dog and hog. These animals have a delicate smell in these matters and only bring out of the soil the ripe truffles while they leave the others. Man is not able to make this nice distinction, and harvests all indiscriminately, from which there results great financial loss. In the harvesting of truffles the ground should be gone over about once in eight days in order that the tubercles may be secured during the whole winter at the proper time of maturity. When the truffles are developed the soil above them is hilled or cracked, especially after rains. These are the places which are selected for the harvesting when it is done by the hand of man.

Harvesting by Means of Flies.—When the weather is warm and clear there is seen above the place where the tubers are lying, a multitude of flies,—these mark the place where the harvest should be made. The best time for this kind of a harvest is about nine o'clock in the morning. Good results are not obtainable from this sign except when the sun rises clear and becomes afterward warm. In order to find the flies the husbandman stoops down near the surface of the soil and looks horizontally over it. The colonies of flies are thus easily distinguished, and below each one of these colonies the truffles are found. This is also an ineffective method because only the over-ripened tubercles attract the flies while those in their very prime are not thus marked.

Harvesting with Hogs.—The utilization of hogs for harvesting purposes is by far the best and most economical method. It is employed especially in Périgord and Midi. The harvesting can be either in the morning or afternoon. The hogs which are used for harvesting should be previously well fed in order to prevent them from eating the truffles which they dig out of the ground. Each animal is led with a rope. As soon as the hog gets the scent of truffles it pounces upon them and rapidly uncovers them with its snout. When the weather is favorable a hog can easily smell a truffle at a distance of 150 feet. As soon as the animal has brought the truffle to the surface instead of allowing him to eat it he should be recompensed by giving him some suitable food such as maize. If this little attention is neglected the animal soon becomes discouraged and refuses to work any longer. Before leaving the spot the hog assures himself that no other truffles are contained in that neighborhood. When the hog becomes very tired he walks very slowly and with his mouth open. It is then necessary to give him a period of rest before continuing the harvest. If the search for truffles does not bring good results the animal becomes morose, indolent, and refuses to obey. Sometimes when the hog is hungry and wants to eat the truffles it is necessary to give him a smart blow on the snout with a stick. A special race of hogs is used in this harvesting whose parents have also possessed the skill, and thus it becomes hereditary. A good hog is able to engage in the harvesting from the age of two to 25 years but they do their best work at three or four years. A single animal may be able to harvest from six to 40 pounds of truffles per day, according to their abundance in the soil. This class of hogs have a very high value, and are often sold in the south of France for this sole purpose at from $30.00 to $70.00 per head.

Harvesting with the Dog.—The dog is also employed in regions where truffles are produced, and especially in those regions where the yield is not so great and where the area to be gone over is very large. The dog is used especially in the Dauphiné, Champagne, Bourgogne, Provence, and Languedoc, and also in the neighborhood of Paris. These dogs are trained, as in the case of hogs, especially for this purpose and should be rewarded when a find is made, in the same manner as the hog. This recognition of their services should never be forgotten if animals of the greatest skill are to be secured. The dog, as is the case with the hog, locates the truffles by the scent and digs with his four paws until the truffles are laid bare,—the husbandman then draws them out of the soil with long forceps. The hog is preferable to the dog because it does the whole harvesting itself, whereas in the case of the dog the husbandman must finish the operation.

The yield of the truffle farm is naturally extremely valuable, varying with the relative abundance of growth and character of the soil itself. Sometimes the yield drops as low as five pounds per acre and sometimes rises as high as 70 pounds per acre. The average price of truffles is $2.00 per pound. The largest yield is found in the truffle farms from the tenth to the twentieth year.

Properties of Truffles.—It is difficult to describe the properties of truffles. They are, when prepared for the table, black, rather firm in flesh, and have a distinct and most agreeable odor and taste. A good truffle is extremely firm and resists the ordinary pressure of the finger. If it is soft it shows that it is lacking in its best characteristic.

The size of the truffle has a marked influence upon its value because the small truffle loses a large part of its weight in the preparation for eating. Truffles of good size are those which weigh from 40 to 50 grams, those of first choice weighing from 60 to 100 grams. After the truffle passes 100 grams in weight the increased weight does not proportionately increase the value. The truffles which come from light soil are considered superior to those which come from rich soil. If the soil contains a large quantity of iron the truffles are usually of finer quality. All truffles are not black, though the best ones, like those of Périgord, are black. Others are gray or brown.

Adulteration of Truffles.—Commerce in truffles is the subject of considerable fraud on account of the very high price of the genuine article. The principal adulterations are the mixture of the inferior or imperfect varieties with the choicest or best varieties. This adulteration is easily discovered by making a careful examination of the tubercles individually. Another fraud which is very much practiced is the introduction of soil into the cracks or crevices in order to increase their weight. This adulteration, of course, is easily discovered by anyone who prepares the truffles for the table. Another form of adulteration is the mingling with the ripe truffle of those which have not reached maturity. The unripe tubercles have very little flavor or taste and are thus easily distinguished from those which are mature. Also practiced is the pressing together with some kind of a glue of a number of smaller truffles in order to form a large mass, as if it were an entire truffle, and thus securing a larger price. This is also a fraud easily discovered. Still another form of sophistication is the production of artificial truffles made from potatoes and especially those which are partially spoiled which are colored in imitation of the truffle itself. Only those who are ignorant of the texture of the truffle can be deceived by this gross imitation. Another form of adulteration is the sale of the truffle coming from regions less esteemed for their products for those of other more esteemed regions as for instance, the sale of truffles from Sarladais or from Domme for those of Périgord.

Preservation of the Truffle During Transit.—For the purpose of keeping truffles in good condition during transit they may be placed in moss, fine sand, or powdered chalk. They can be kept in this way for a few days during transit, but should not be long preserved in this manner. Truffles may also be preserved indefinitely by sterilization. It is necessary to do this whenever they are to be sent over long distances or kept for a long time. The methods of sterilizing are not different from those described for ordinary vegetables. Truffles are also preserved by desiccation, but in this case they lose something of their odor and taste and are not so highly esteemed. Finally the truffles are sometimes preserved by cooking them and preserving them in wine or olive oil. (Raymond Brunet, "Manuel Pratique de la Culture des Champignons et de la Truffe.")

Food Value of Fungi.—While the mushroom and the truffle are the principal fungi used as food they are by no means the only kinds. Their value, as has already been indicated, is rather condimental than nutritive. Those, however, who have eaten fresh or well preserved mushrooms or truffles, cooked in the best style of the culinary art, are fully acquainted with their value. The fear of poisoning does much to restrict the use of the wild mushrooms. The fields and forests are full of many varieties of these fungi, especially in the autumn. Very few of the varieties are poisonous, but the conservative gourmand hesitates to consume the fruits of his own activity as a collector. In the hills of the Blue Ridge Mountains near Harper's Ferry I have seen large areas of the forest almost covered with these growths in August and September, but the courage leading to their consumption was wanting.

In order to guard against any danger in the consumption of fungi of this kind it is highly desirable that some more certain index of innocence be available than mere appearance. Experiments might be made to see whether the extract of the sample would poison flies when fed mixed with some sweet substance which would encourage consumption. Even a small chicken or other small domesticated animal could be fed a considerable quantity of the sample and the result awaited. Such precautions would largely or entirely prevent the very serious consequences of ingesting poisonous varieties. If such precautions are not used the quantity of a mushroom of unknown character consumed should be limited to a very small amount. This would avoid the danger of a fatal result. The best of all precautions, however, in the presence of strange varieties of mushrooms, is complete abstention.

It is quite dangerous for the unskilled to be guided by the pictures or descriptions of the toxic fungi. In this case, however, nature has provided very many innocent varieties for each one that is poisonous. The probability of immunity, however, is not a license to promiscuous consumption.

PART IX.

SUGAR, SIRUP, CONFECTIONERY, AND HONEY.

SUGAR.

The term "sugar" is applied by common consent to the pure sugar commercially prepared from the sugar cane and the sugar beet. These two kinds of sugar are sometimes designated by their own name, as, for instance, the purchaser will ask for cane sugar or beet sugar. When no other name appears the term sugar is applied as above.

In Europe the principal sugar used is that derived from the sugar beet. In the United States the principal sugar is that derived from the sugar cane. Notable quantities of sugar are also found in commerce derived from the maple tree, a small quantity from sorghum, and in Asia a considerable quantity is made from the palm.

Chemically, sugar belongs to the class of bodies known as sucrose or saccharose and is a compound in a pure state consisting solely of carbon, oxygen, and hydrogen, typical of that class of foods of which starch is the most important member, known as carbohydrates. The elements mentioned are combined in sugar in the proportion of 12 parts of carbon, 22 of hydrogen, and 11 of oxygen.

The quantity of sugar consumed by the people of the United States is very large. Excluding molasses, honey, and sirups the quantity consumed in the United States in the year ending December 31, 1905, was 2,632,216 tons. There should be added to this the total quantity of sugar found in the articles of diet which are so common in this country in the form of honey, sirups, and molasses.

Origin of Sugar.—In the earliest times practically the only sugar which was used by man was that stored by the bees, namely, honey. The sugar cane is indigenous to Asia and was not known as a source of sugar in Europe until the 13th or 14th century, when it was brought by Eastern merchants to Europe. The discovery of America and the introduction of sugar cane into the islands adjacent thereto opened up a new field for the culture of that plant and laid the foundation of the great industry which followed. It was not, however, until 100 years ago that the sugar cane industry assumed anything like the proportions which indicated its subsequent growth. About 1747 sugar cane was introduced into Louisiana and soon thereafter, about 1790, became one of the most important crops of that state. Until the beginning of the Civil War Louisiana produced a large proportion of the cane sugar consumed in the United States. During the Civil War the industry was almost totally destroyed, but since then it has grown until it has assumed greater proportions than ever before but constantly diminishing proportions in relation to the total supply. Louisiana is somewhat too far north for the most economic production of sugar cane, since it is subject to injury by frosts. Sugar cane is a plant which is very sensitive to cold weather and is usually killed by a hard frost. For this reason its greatest development has occurred in tropical countries, especially in Cuba, the Hawaiian Islands, and in other similar localities. At the present time by far the largest part of the sugar made from sugar cane in the world is produced in Cuba and the Hawaiian Islands,—the Cuban crop amounting, in round numbers, to 1,200,000 tons and the Hawaiian to about 400,000 tons.

Beet Sugar.—The fact that beet sugar is contained in the common garden beet was first discovered by a German chemist, Margraff, in 1747. This important discovery remained dormant for nearly half a century when one of Margraff's pupils, the son of a French refugee from Prussia, named Achard, resumed the researches which had been started by Margraff and obtained results which were then regarded as of an astonishing character. Achard's statements were the subject of doubt and of ridicule and even his French co-laborers, members of the academy, doubted the accuracy of his work, while thinking it of sufficient interest to look into further. A commission consisting of some of the most important members of the Academy of Science, among them Chaptal and Vauquelin, investigated the matter and announced that the attempt to make sugar was unsuccessful but thought perhaps the maple tree might be grown in France. Nevertheless the commission modified the methods of Achard and obtained better results. This was the beginning of that long series of investigations which has resulted in the establishment of a beet sugar industry, making in round numbers six million tons of sugar per year, a quantity considerable greater than that produced from the sugar cane. The name of Chaptal has been mentioned as belonging to the commission which was appointed to study Achard's process because it was through the influence of Chaptal, who had then become a Count, that the Emperor Napoleon on January 15, 1811, issued his decree establishing the beet sugar industry as a national industry of France and granting a subvention thereto. This decree ordered that one hundred thousand hectares should be planted in beets in France. Both the taxes and the octroi were withdrawn upon all sugar produced from beets for a period of four years. There were also to be established, according to the decree, four central beet sugar factories, and it was ordered that the crop of sugar beets in 1812 and 1813 should reach two million kilograms of raw sugar. The disastrous Russian campaign and the subsequent fall of the Napoleonic dynasty interrupted but did not destroy the industry.

The establishment of an industry by imperial decree is perhaps a novel method of procedure and gave rise at that time to a caricature in which the Emperor Napoleon and the young King of Rome figured as the most important characters. The Emperor was represented as seated in the nursery with a cup of coffee before him into which he was squeezing the juice of a beet. Near him was seated the young King of Rome voraciously sucking a beet root while the nurse standing near and steadfastly observing the process is saying to the youthful monarch—"Suck, dear, suck, your father says it's sugar."

By reason of the embargo laid on commerce by England the cane sugar coming from tropical islands had been kept out of the continent, so in order to supply the deficiency the Emperor Napoleon issued the decree mentioned. Due to this impetus the industry grew rapidly in France even after the fall of the empire and in the course of 20 years had assumed proportions of commercial importance. About this period German scientists became interested in the matter and by studies directed to the improvement of the sugar in the beet and methods of manufacture laid the foundation of a great industry in Germany which has outclassed the similar industries of all other countries.

The production of beet sugar in the United States was only a few thousand pounds in 1879 and during that and succeeding years a number of factories were built. All of these, however, were unsuccessful except one which was located in Alvarado, California, and which has been continuously operated ever since. In 1884 the U. S. Department of Agriculture undertook anew the investigation of the conditions which were favorable to the sugar beet industry and as a result of these investigations a new start was made on a more substantial basis. The industry has since then grown extensively in importance until at the present time more sugar is made from the sugar beet in this country than from the sugar cane. In order that an adequate idea of the magnitude of the sugar industry of the world may be gained a statistical table is submitted on page 471, showing the production of sugar in the world during the year 1909.

The first important report on the beet sugar industry in the United States was made by McMurtrie as a special report No. 28 on the culture of the sugar beet, issued in 1880 by the Department of Agriculture. It is there recounted that two Philadelphians, as early as 1880, became interested in the beet sugar industry which was then in its infancy in Europe. Eight years later David L. Child undertook in a small way the production of beet sugar in Northampton, Mass., and issued a small work on the subject, entitled "The Culture of the Beet and the Manufacture of Beet Sugar." He reports that he had grown beets that would yield 6 percent of sugar which cost not more than 11 cents a pound. He made in all about one thousand, three hundred pounds of sugar.

The first factory of any considerable size in the United States was erected in 1863 at Chatsworth, Ill., but this proved to be a financial failure. A beet sugar factory was erected in the Sacramento Valley, California, in 1869, and after various vicissitudes a permanent factory was established at Alvarado,

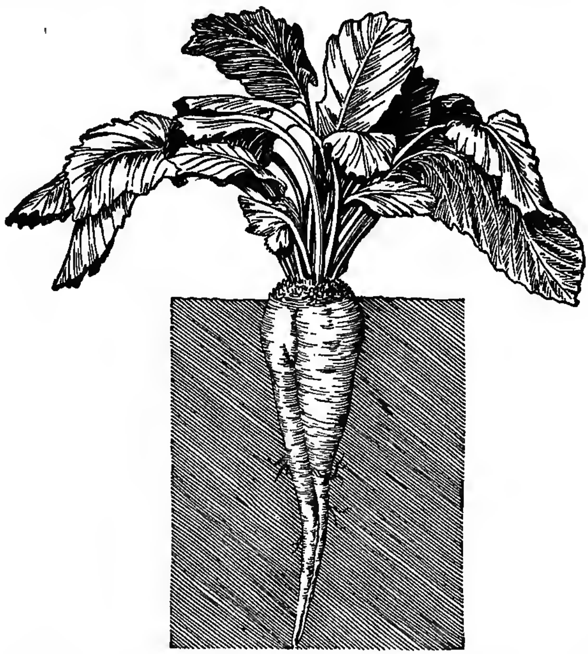


Fig. 68.—Correct Position of a Mature Beet in the Soil.—(*Farmers' Bulletin 52.*)

as has already been mentioned. In 1874 as much as 1,500,000 pounds of beet sugar were made in California. In 1870 and 1871 New Jersey and Massachusetts enacted legislation exempting from taxation for a period of 10 years all property devoted to the production of beet sugar. Factories were established in Massachusetts and in Delaware later on, but these all suffered financial reverses. It was not until the latter part of the 80's that the beet sugar industry in the United States was placed upon a paying basis, and even since that date many ventures in the manufacture of beet sugar have resulted in financial loss and in the abandonment of the factories.

Conditions of Cultivation.—The sugar beet in the United States does not

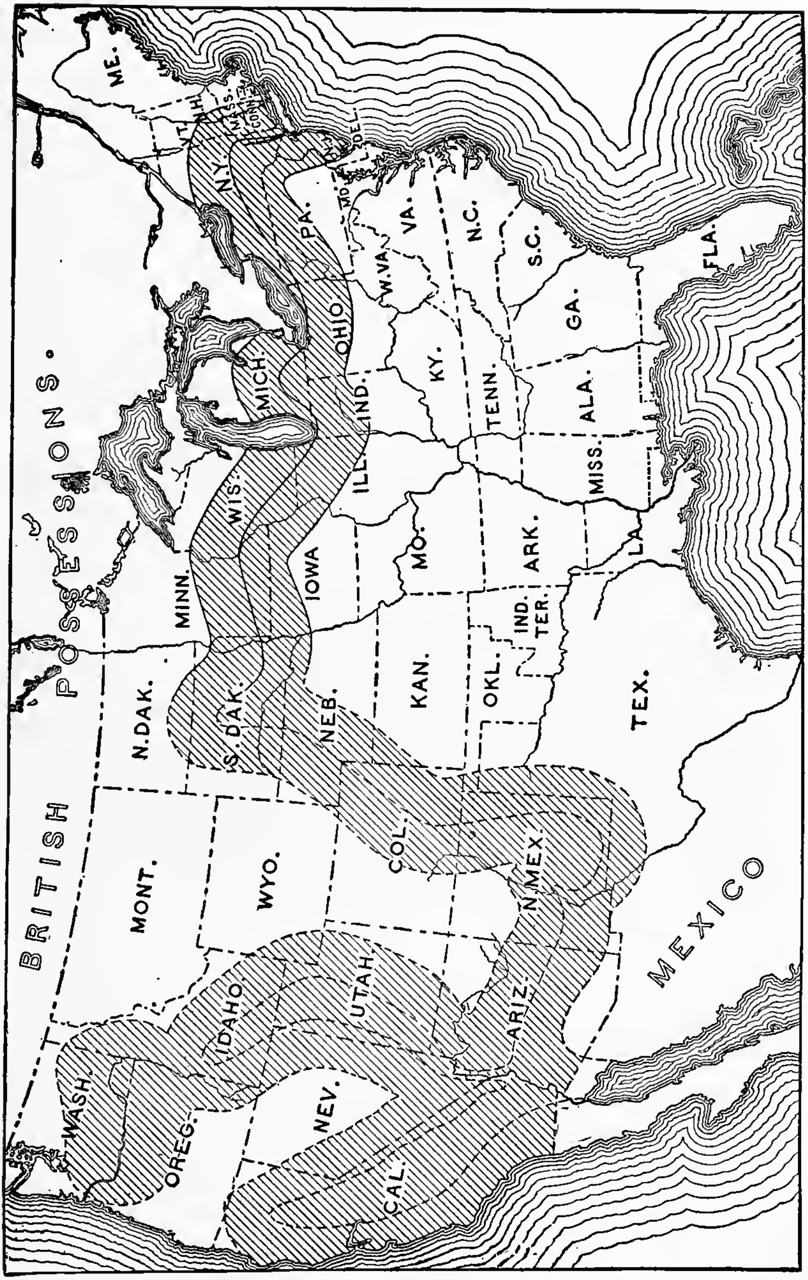


FIG. 69.—MAP SHOWING TEMPERATURE ZONE IN WHICH THE SUGAR BEET ATTAINS ITS GREATEST PERFECTION.—(*Farmers' Bulletin No. 52, Department of Agriculture.*)

produce its maximum content of sugar in areas where the mean temperature for the three months of June, July, and August rises above 70 degrees F. The southern limit of this area is an irregular, waving line, as indicated in the accompanying map (Fig. 69). There are, of course, localities where high-grade beets can be produced south of this line, but in point of fact nearly every successful beet sugar enterprise has been located within the field indicated. There is really no limit to the northern edge of this belt except that of short seasons, incident to late frosts of spring and early frosts of autumn. To successfully compete in the sugar markets of the world the sugar beet should enter the factory with an average percentage of sugar of not less than

FIG. 70.—A FIELD OF BEETS READY FOR HARVESTING. —(*Bureau of Plant Industry.*)

12. Very much richer beets are often produced and in some of the irrigated areas of the west, where the climate is remarkably dry, an average percentage of 16 and 18 even has been obtained. In the whole beet sugar crop of the United States the average percentage of sugar in the beet is probably not far from 13 or 14. In this respect it is seen that the beet is richer in sugar than the average sugar cane of Louisiana, which does not contain over 11 or 12 percent of sugar.

Yield per Acre.—The average yield per acre of sugar beets in the United States is unfortunately very low, due chiefly to ignorance of the proper method of culture. The sugar beet is more of a garden than a field crop and requires special cultivation and fertilization. The average yield in the United States has probably not exceeded eight tons per acre, while the average yield in Europe is twelve or thirteen tons per acre. In this respect the Louisiana sugar cane has a marked advantage, the average crop being over twenty tons, while thirty and even forty tons are often obtained. As soon as our farmers learn the principles of culture it is certain that the average yield in the United States will be as great as that in Europe. A typical field of beets ready for the harvest is shown in Fig. 70.

Manufacture.—The manufacture of beet sugar is both a simple and a complicated operation. The simplicity of it consists in the fact that it is only necessary to extract the saccharine juices of the beet, properly clarify

FIG. 71.—BEETS READY FOR TRANSPORTATION TO FACTORY.—(*Bureau of Plant Industry.*)

them, and reduce them by evaporation to a point where the sugar will crystallize. In reality the operation of successful manufacture requires elaborate and costly machinery and a high degree of technical skill. A brief outline of the method will be sufficient for the purpose of this manual.

The beets, after harvesting, have the tops cut off with a small quantity of the adhering material of the neck of the beet, which contains large quantities of salts and is not suitable to enter the factory. In Fig. 71 is shown a view of a beet field after the harvest. The beets are then thoroughly washed and passed through a slicing machine in which they are cut up into thin slices or ribbons. They then enter a series of tanks, known as a diffusion battery, in which they are thoroughly treated with hot water, by means of which practically all of the sugar which they contain is extracted. The saccharine product obtained, known as the diffusion juice, is treated with a

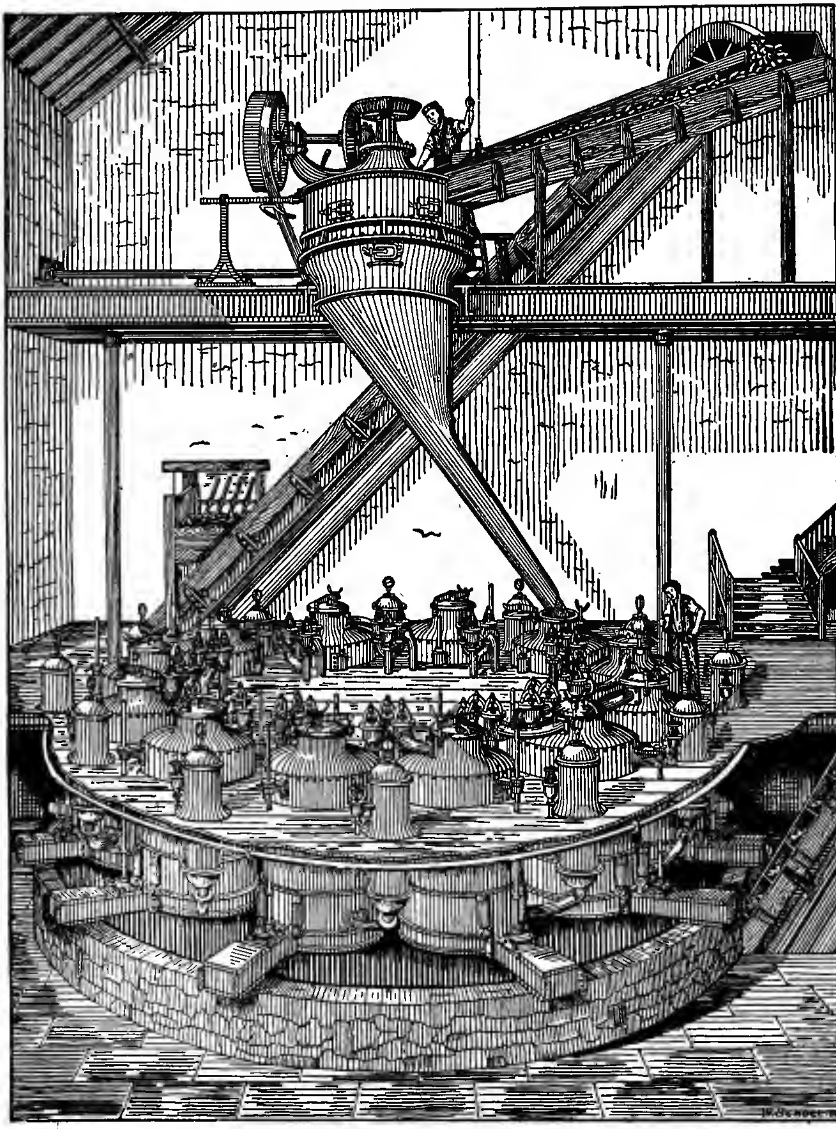


FIG. 72.—DIFFUSION BATTERY.—(*Farmer's Bulletin 52.*)

large excess of lime, heated, and carbonic acid derived from a lime kiln blown through it until the lime is all converted into a carbonate carrying down with it the impurities of the juices. The diffusion juice as it comes from the diffusion battery is usually almost as black as ink. After carbonatation, as the process above is called, it is of a clear, light amber tint. To separate the liquid from the solid matter the whole is passed through a filter press from which the juice emerges bright and clear and the carbonate of lime with its adhering impurities remains in the filter press as hard cakes. This process is repeated in order to secure as great a purity as possible in the juice.

Evaporation.—The purified juice is conducted into multiple-effect vacuum pans, Fig. 73, from which the air is partially exhausted by a pump, the vacuum thus rising in the series. There are usually three or four of these pans joined together,—the first one having the least air exhausted from it and the last one the most, that is, having the highest vacuum. The vapor which arises from the first pan is conducted through the copper coils to the second and serves as the heating agent while the vapor from the second pan passes through the copper coils to the third and so on to the fourth. Thus the steam used for evaporating is turned only on the first pan and by this means a great economy in the use of fuel is secured. In this way the juice is evaporated to a sirup. This is usually somewhat colored and if white sugar is made it is bleached by passing through bone-black or by the application of sulfur fumes. When sulfur is used it is often applied first to the unevaporated juice as well as to the sirup.

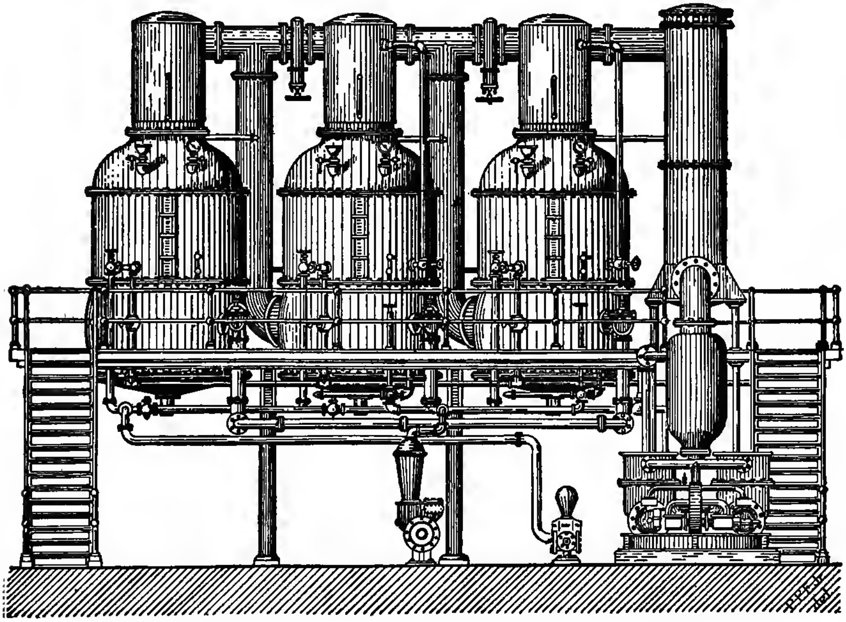


FIG. 73.—MULTIPLE-EFFECT EVAPORATING APPARATUS.—(*Farmers' Bulletin 52.*)

Final Crystallization.—The sirup is now ready for the final process, which takes place in what is known as the vacuum strike pan, Fig. 74. A considerable quantity of sirup is introduced so as to cover the lower coils of this pan and, after the vacuum is established by a pump, evaporated to the crystallizing point. An additional quantity of cold sirup is then drawn into the pan, chilling the mass and thus producing incipient crystallization in the form of extremely minute crystals. The evaporation is now continued with the addition of sirup from time to time, by which process the sugar crystals begin to grow. In the course of a few hours the pan is full of crystals of the size desired.

Purification of the Sugar.—The vacuum is broken and the crystallized

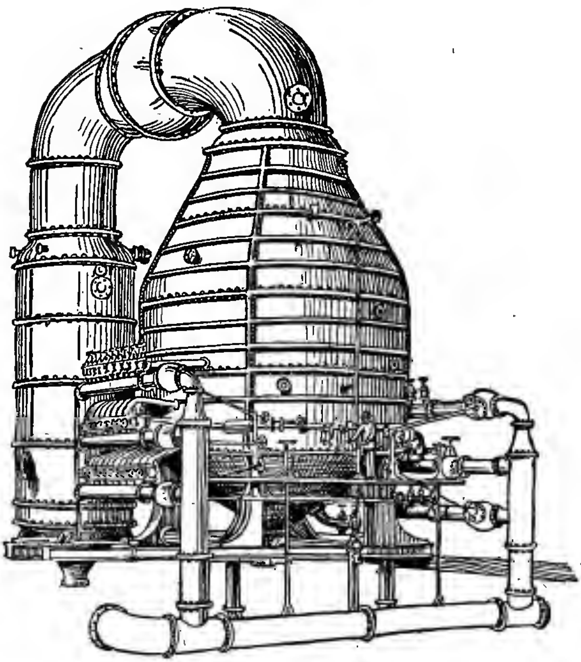


FIG. 74.—VACUUM STRIKE PAN.—(*Farmers' Bulletin 52.*)

mass of sugar drawn into a mixing apparatus whereby all lumps are broken up and a uniform magma secured. Thie is done while the mass is still warm. Were it allowed to cool it would be extremely difficult to break it up. The warm mixture is then passed into the centrifugal machine, by means of which the molasses is separated from the crystals and these remain as white pure crystals in the pan. The whole process of separating the juice from the massecuite, as the mass is called, occupies only a few minutes. Thus the sugar is often centrifugalled and in the barrels before it is cold from the vacuum pan.

The above is merely the outline of a method which requires complicated apparatus, often of extensive proportions, and which could not be described in detail except in a technical work. It gives the reader, however, an idea of how the beet sugar which he eats is made. Often white sugar is not made at the sugar factory, in which case the bleaching with bone-black, etc., is omitted and a brown sugar is produced which afterward goes to the refinery.

FIG. 75.—SUGAR CANE FIELD READY FOR HARVEST.—(*Photographed by H. W. Wiley.*)

Growth of Sugar Cane.—The growth of sugar cane is confined to tropical and subtropical regions. In the United States this crop is grown chiefly in Louisiana and Texas. Its cultivation does not extend northward beyond the center of Georgia. Typical scenes in sugar cane fields are shown in Figs. 75 and 76.

Manufacture of Cane Sugar.—In the manufacture of sugar from the sugar cane the first process, naturally, after the harvest, is the expression of the juice from the cane. At the time of harvesting the canes are topped in such a way as to cut off the green portion of the upper part of the stalk and the leaves also are removed.

There are two methods of extracting the juice from the cane, one similar to that described for the sugar beet but used very little. Only one or two factories in the United States use this method of extraction. The most common method of extraction is by passing the canes through heavy mills.

FIG. 76.—CANE FIELD PARTLY HARVESTED.—(*Photographed by H. W. Wiley.*)

These mills are made of great strength so as to bear an immense pressure without breaking. The largest mills have a capacity of grinding from 500 to 1000 tons of cane a day. Many of them grind only from 200 to 500 tons per day. The mills are nearly always placed in series, that is, the cane is subjected to a double pressure. The first mill is uniformly composed of three rollers of the same size and set so that the first and second are not quite so close together as the second and third. The second mill also often consists of three rollers the same as the first mill, but sometimes only two. Occasionally a third mill is used. It is customary to sprinkle the crushed cane as it comes from the first mill with water before it enters the second mill, thus securing a greater degree of extraction. The residue from the mill is called bagasse and is commonly carried directly to the furnace and used as fuel, furnishing steam, to evaporate the juice and drive the mill. The mills extract from 75 to 80 percent of the weight of cane in juice. The sugar cane contains about 88 percent of its weight of sugar juice. It is seen, therefore, that a considerable portion of the sugar remains in the bagasse. By the process of diffusion a larger proportion of the sugar is extracted than by milling, but the resulting juices are very much diluted and require a greater combustion of fuel for evaporation.

Clarifying the Juice.—The juice as expressed from the cane is a dirty-looking mass and requires to be clarified before it is concentrated. It is a very common practice to subject the fresh juice to the fumes of burning sulfur. In all cases the first step in the clarifying is the addition of lime to neutralize the natural acidity of the juice and facilitate the coagulation of the dissolved matter. The limed juice is next subjected to heating and as the boiling point approaches a separation of the suspended and coagulated matter takes place, the light coming to the top and the heavy falling to the bottom. The common method of separating these bodies is by skimming the top coagulum and settling the bottom portion and drawing off the clear juice therefrom. In addition to this to get a more complete separation the heated juice may be run through a filter press.

The clarification of sugar cane juice, as is seen, is much more simple than that of beet juice. The method employed for the clarification of beet juice is sometimes used for cane juice but not very frequently.

Evaporation of Clarified Juice.—After the clarification is completed the further treatment of the juice is exactly the same as that for the sugar beet.

Manufacture of Maple Sugar.—The maple trees in the United States grow in the New England states, especially in Vermont, and in New York, Ohio, and Indiana. Very little sugar is made in other states. The season of manufacture is at the beginning of spring, when the sap first begins to run and before the buds of the new leaves have developed very extensively. The season lasts from four to six weeks. In New England it begins the latter part of March and in Ohio and Indiana in February. The trees are bored and a tubular spile driven into the wood through which the sap escapes into the bucket or other receptacle. Figs. 77, 78, and 79 are typical scenes in a small maple orchard during the season, showing tapping of the trees and collection and boiling of the sap. The sap of the maple tree is extremely clear and requires but little clarifying. It is usually evaporated in open kettles or pans, the vacuum process not being employed. The crystallization

FIG. 77.—TAPPING THE MAPLE TREES.—(*Courtesy Forest Service, Department of Agriculture.*)

FIG. 78.—TRANSPORTING THE SAP TO THE SUGAR HOUSE.—(*Courtesy Forest Service, Department of Agriculture.*)

takes place at the final moment of evaporation and usually the whole mass is sold as sugar, forming what is known in the cane sugar industry as concrete. Maple sugar is never refined, since in the process of refining the peculiar flavor and odor which give it its chief value would disappear. The quantity of maple sugar made in the United States is almost negligible from a commercial point of view, amounting annually to only about 10,000 tons. Perhaps a greater quantity of maple sap is used in the form of sirup than of sugar.

Refining of Sugar.—All kinds of raw sugar but maple are refined before entering commerce. The public taste has demanded a pure white sugar and in so far as beet sugar is concerned the refining process is a necessity, inasmuch as raw beet sugar has a very disagreeable soapy taste and odor

FIG. 79.—BOILING THE MAPLE SAP.—(*Courtesy Forest Service, Department of Agriculture.*)

which render it unfit for consumption. On the other hand raw cane sugar is aromatic, fragrant, and delicious to a far greater degree in the raw state than when it is refined, since after the refining process it is difficult to distinguish the product of the beet juice from that of the sugar cane.

Process of Refining.—The manipulation attending the refining of sugar is a somewhat simple one, but experience has shown that it can only be done economically in very large establishments, many of which cost millions of dollars. The attempt to refine sugar on a small scale makes the product too expensive to compete commercially with the product of the large refinery. The raw sugar is first mixed with water and melted and reduced to the condition of a sirup. In this state it is treated with lime and clarified as has been described for sugar cane juice. Sometimes at this stage it is also treated with sulfur fumes, but not usually. After clarifying the juice is filtered through bags or filter presses so as to free it from all suspended matter. In order to decolorize it it is then passed through large cylinders filled with bone-black from which it emerges quite or almost water-white. When the bone-black loses its decolorizing properties it is removed from the cylinder and reburned in closed retorts, by which process it regains its power to decolorize the sugar solution. The decolorized juices are next taken into vacuum strike pans, as has already been described in the manufacture of sugar, only of a much larger size. In these pans they are evaporated and crystallized and the sugar separated in centrifugals as described above. After the sugar comes from the centrifugal it is placed in a granulating apparatus, a large revolving drum supplied with a steam jacket from which it emerges dry. Granulated sugar is almost chemically pure, often containing 99.9 percent of pure sugar. The molasses from the centrifugal is diluted, passed through bone-black, and reboiled and a new lot of sugar obtained. Finally when the product becomes so low in sugar as not to yield a white product lower grades of brown sugar are made, which are usually sold without drying and contain considerable quantities of moisture and some molasses. The final molasses which no longer crystallizes is sold usually for mixing with glucose to make table sirup. It contains so much mineral matter in solution as to be hardly suitable for food purposes.

Loaf sugar, cut loaf, etc., are forms of pure sugar which are pressed or cut in the forms in which they appear on the market and then dried instead of being dried in a granulated state as described. Powdered sugar is dry refined sugar reduced to a fine powder.

In the refining of sugar it is quite customary to wash the crystals in the centrifugal with ultramarine blue suspended in water. This is done in order to form with the blue water and the yellow tint, which sometimes accompanies the crystals, a perfectly white appearance, on the optical principle which shows that when a blue and a yellow tint are mixed a white color results. This process is not required for the first-class product coming from the first crystallization and very often dealers require sugar for special purposes which has not been so treated. It would be advisable if all consumers should demand a sugar of the same character.

While the refining of sugar can probably never be abolished it should not be forgotten that the very finest sugar, from a palatable point of view, is that made from the maple or sugar cane without refining in which the crystals retain their natural yellow color. If consumers understood thoroughly the value of a sugar of this kind they would demand it instead of the dead white product which is now in vogue.

As has been stated a raw sugar of this kind could not be used if made from beets.

Sugar Crops of the World.—These figures include local consumption of home production wherever known and are taken from Willett and Gray's estimates of the world's sugar crops, being stated in tons of 2,240 pounds:

Country.	1905–6.	1906–7.	1907–8.	1908–9.	1909–10.
CANE SUGAR.					
NORTH AMERICA.					
United States:					
Contiguous—	*Tons.*	*Tons.*	*Tons*	*Tons.*	*Tons.*
Louisiana	336,752	230,000	340,000	355,000	325 000
Texas	12,000	13,000	12,000	15,000	10,000
Noncontiguous—					
Hawaii	383,225	392,871	465,288	477,817	490,000
Porto Rico	213,000	210,000	200,000	245,000	280,009
Total United States	944,977	845,871	1 017,288	1,092 817	1,105,000
Cuba	1,178,749	1,427,673	961,958	1,513,582	1,700,000
Mexico, Central America, West Indies	428,208	414,500	398,182	402,061	467,000
Total	2,551,934	2 ,688,044	2,777,428	3,008,460	3,272,000
South America	700,001	628,777	540,518	694,655	684,000
Europe:					
Spain	15,722	16,400	11,000	20,000	16,000
Asia	2,926,209	3,443,794	3,421,827	3,353,685	3,260,000
Africa	317,967	326,825	284,870	318,992	395,000
Oceanica	230,000	249,000	280,725	231,098	217,328
Grand total, cane sugar	6,741,833	7,352,840	6,916,368	7,626,890	7,844,328
BEET SUGAR.					
NORTH AMERICA.					
United States	279,393	431,796	413,954	380,254	457,562
Canada	11,419	11,367	7,943	6,964	8,802
Total	290,812	443,163	421,897	387,218	466,364
EUROPE.					
Austria-Hungary	1,509,789	1,343,940	1,424,657	1,398,000	1,260,000
Belgium	328,770	282,804	232,352	258,000	250,000
France	1,089,684	756,094	727,712	802,000	825,000
Germany	2,418,156	2,239,179	2,120,597	2,080,000	2,040,000
Netherlands	207,189	181,417	175,184	214,000	200,000
Russia	968,500	1,440,130	1,410,000	1,265,000	1,150,000
Other countries	410,255	467,244	462,772	500,000	460,000
Total	6,932,343	6,710,808	6,562,274	6,517,000	6,185,000
Grand total, beet sugar	7,223,155	7,153,971	6,984,171	6,904,218	6,651,364
Grand total, cane and beet sugar	13,964,988	14,506,811	13,900,539	14,531,108	14,495,692

Adulteration of Sugar.—In the United States there are few adulterations of sugar practiced. The product has grown so cheap not only in the United States but all over the world that such practices are no longer remunerative, and whenever adulteration ceases to pay it requires no law to prevent it. White sugars have been adulterated from time to time by the admixture of white earth or terra alba (either ground silicate, ground gypsum, or ground chalk). I have never found any sophistication of this kind in an American white sugar. White flour has also been added to sugar as an adulterant, but that form of adulteration is not known in this country. The only adulteration which is found in American sugar, in so far as I know, is that incident to the process of manufacture which I have described. When sulfur is used in sulfuring the juice before clarifying a trace of sulfurous acid may still adhere to the finished product. When bluing is used the particles of ultramarine blue attach themselves to the sugar crystals and become an adulteration. I have seen sugar so blued that on solution the water would turn blue. Sugar granules are also sometimes washed with salts of tin, a very poisonous compound, and a trace of these salts may still adhere to the crystals. Sugar has also been mixed with dextrose made from starch, in other words, from starch sugar, or as it is ordinarily called, anhydrous grape sugar. This is a form of adulteration which has been little practiced on account of the difficulty of getting a dry starch sugar in commercial quantities. Recent improvements in the manufacture of dextrose have made it very probable that this form of adulteration may be more frequent in the future. As a food product pure dextrose is probably as valuable as sugar, but if it can be made cheaper it would become a fraudulent adulteration or if added in any way without notice its addition is fraudulent and constitutes an adulteration. There is little, however, to fear from this form of adulteration as long as the price of sugar does not go much above 5 cents per pound.

Sugar as a Food.—The food value of sugar is well defined. It furnishes next to oil and fat the most complete food for heat and energy that can be consumed, ranking, of course, as starch in this particular. Sugar is a quick-acting food and therefore is especially valuable to relieve exhaustion. It is particularly useful for soldiers on a forced march or for people engaged in any extraordinary effort. A lump of sugar eaten occasionally keeps up the strength and prevents exhaustion. The value of sugar as a food is not appreciated as it should be, since it is valued mostly for its condimental and preservative properties.

SIRUP.

A very common form in which sugar is used in this country is in the form of sirup. The United States more than any other nation consumes viscous liquid solutions of sugar as a condimental food product, especially at breakfast on hot cakes and other articles of diet. Table sirup is an almost uniform article of diet upon the American breakfast table whether in the household, the hotel, or restaurant.

Maple Sirup.—Among the sirups, first of all must be mentioned the most valuable and highly appreciated, namely, maple sirup. Maple sirup is the product of the evaporation of the juice of the sap of the maple tree to a consistency in which only about 30 or 35 percent of its weight is water. This is sufficient to prevent the crystallization of the sugar for at least a reasonable length of time. Maple sirup is best when freshly made, and if kept through the summer should be put in tins and tightly sealed while hot. In this condition it will keep its original flavor almost entirely, whereas if left in barrels or other ordinary receptacles its flavor is impaired. Maple sirup is also made by dissolving maple sugar as occasion may require, but this kind is not so highly prized as that made directly from the maple sap.

FIG. 80.—SMALL PRIMITIVE MILL FOR EXTRACTING JUICE FROM SUGAR CANE FOR SIRUP MAKING. —(*Photograph by H. W. Wiley.*)

Analysis of Maple Sirup.—The average composition of ten samples of maple sirup of known purity is as follows:

Total solids,	70.50	percent
Water,	31.40	"
Ash,	.53	"
Sucrose,	64.10	"
Reducing sugar,	1.30	"

The study of the ash of maple sirup is an important point in connection with its purity. It is distinctly different from the ash of the sugar cane and

FIG. 81.—MILL AND EVAPORATING APPARATUS FOR SIRUP MAKING IN GEORGIA.—(*Bulletin 70, Bureau of Chemistry.*)

sorghum, and its study should not be neglected in all cases where there is any doubt respecting the genuineness of the samples.

Cane Sirup.—Sugar cane sirup is made by expressing the juice of the sugar cane as described, clarifying, and evaporating the juice to a consistency where only about 25 or 30 percent of the water remains, which is sufficient to prevent the sugar from crystallizing for a reasonable length of time. Sugar cane sirup is made in hundreds of small factories in the states of Texas, Louisiana,

FIG. 82.—RELATIVE LENGTH OF CANES USED FOR SIRUP MAKING.—(*Photograph by H. W. Wiley.*)

Alabama, Mississippi, Georgia, South Carolina, and Florida. It is usually made in a small way with mills driven by a horse or mule and with primitive methods of evaporation in an ordinary kettle. Hard pine wood is burned for the evaporation and the empyreumatic flavor of the pine is often absorbed by the sirup. In Figs. 80 and 81 are shown typical apparatus used for the manufacture of sirup from sugar cane in Georgia and in Fig. 82 the relative length of canes ready for manufacture. In factories where modern apparatus is used, in so far as I know, the vacuum process is not employed. In fact, except for economy of fuel, the vacuum process would be objectionable, since by boiling in an ordinary open kettle a larger quantity of sugar is inverted and thus the tendency to crystallization is diminished. It is a common but reprehensible practice in making sugar cane sirup to subject the freshly expressed juice to the fumes of burning sulfur. This makes a light-colored sirup but introduces a substance highly objectionable and one which destroys to a certain degree the flavor of the product. Experiments made by the Department of Agriculture show that delicious, wholesome, and palatable sugar cane sirup is best made by clarifying the expressed juice solely by means of heat and mechanical separation of the coagulum. The addition of lime or any other clarifying reagent is unnecessary and only makes a sirup of less desirable and less palatable quality. Since cane sirup is made uniformly in open kettles or pans there is a slight caramelization of the sirup during evaporation that gives a reddish tint to the product, which should be a mark of superiority instead of being so often regarded as a mark of inferiority. The consumer should always be suspicious of a sugar cane sirup which is light in color. It is probably a case of "Greeks bearing gifts" in the form of sulfurous acid or other injurious bleaching materials. Sugar cane sirup is not appreciated by the people of the North. In fact it is rarely seen or consumed by them. In its own country, however, it is a staple article of diet, highly esteemed, wholesome, palatable, and nutritious.

Analysis of Sugar Cane Sirup.—The average composition of thirteen samples of cane sirup of known purity is as follows:

Total solids,	75.0	percent
Water,	25.8	"
Ash,	1.2	"
Sucrose,	52.0	"
Reducing sugar,	17.6	"

Sorghum Sirup.—The sorghum plant (*Sorghum saccharatum*) is grown practically in every state in the Union, but principally in Kansas. Some of the very best sorghum sirup made in the United States, however, is made in Minnesota, and this plant can be used for sirup making purposes over the whole area of the United States.

The method of manufacture is exactly that of sugar cane sirup. It is made in small mills mostly driven by horse power, though some large factories have steam apparatus for its manufacture. It should also be made without the use of any other clarifying reagent than heat. Sorghum sirup has a peculiar flavor which is not disagreeable to those accustomed to its use. It is extremely wholesome, highly nutritious, and palatable. It is a staple article of diet with thousands of families in the United States, principally in the northern and central portion. It rarely is made in the New England states and not very often in those southern states where sugar cane can be used in its place, since the sugar cane makes a sirup which is preferred by most people.

Analysis of Sorghum Sirup.—The average composition of ten samples of sorghum sirup of known purity is as follows:

Total solids	76.0	percent
Water	28.6	"
Ash	4.0	"
Sucrose	36.7	"
Reducing sugar	26.6	"

Molasses.—The term "molasses" is properly applied to the saccharine product which is separated from sugar in the process of manufacture. It is well to clearly discriminate in the use of the term in order that no confusion or misunderstanding may arise. To this end the terms "sirup" and "molasses" may be contrasted. A sirup is the direct product of the evaporation of the juice of a sugar-yielding plant or tree without the removal of any of the sugar. The term molasses applies to the same process with the exception of the fact that sugar has been removed at least partially by crystallization and some kind of mechanical separation of the crystals from the remaining liquid. Molasses, therefore, to use a term employed in chemistry, may be considered the "mother liquid" which has produced the crystallization of the sugar. The production of molasses has already been sufficiently described in the article on sugar making. The molasses is either separated by gravitation as in the old style of drying sugar or, as at the present time, almost exclusively by centrifugal action. The molasses naturally contains all the substances in solution or suspension which are not retained upon the gauze of the centrifugal. It differs from the total mass of evaporated sugar liquid only in the fact that a large portion of the sucrose or crystallizable sugar has been separated. The sugar juices of the cane and sorghum contain considerable quantities of sugar of a kind different from sucrose or common sugar, namely, an invert sugar, a "reducing sugar," as it is called, which consists usually of about equal parts of dextrose and levulose. During the process of manufacture small portions of the sucrose are converted into sugar of this kind thus increasing its quantity. In the final crystallization there is always a portion of sugar uncrystallized remaining as a viscous liquid in contact with the crystallized particles. This natural invert sugar which is in the juice, the small portion formed from the sucrose during the process of manufacture, and the part of sucrose remaining uncrystallized in the mother liquid constitutes the molasses. In the washing of sugar the water which is used also passes into the molasses thus diluting it somewhat from its natural consistence. In the sugar refinery the molasses is made up of practically such materials as just mentioned, but inasmuch as the separation of the sugar is more complete the other portions of the molasses, namely, the mineral salts, particularly appear in a very much larger proportion than in the ordinary molasses as will be seen by the analysis of these bodies.

Varieties of Molasses.—*New Orleans Molasses.*—The real New Orleans molasses is the product of the manufacture of sugar in the old-fashioned way in the open kettle and without the aid of vacuum pans. In this process the crystallization of the sugar does not take place during the boiling but the concentrated liquid is placed in tanks where the crystallization takes place. When this is complete it is broken up into small fragments and placed in a hogshead standing in an upright position, the bottom of which is perforated and covered with straw or fragments of sugar cane. When the hogshead is filled with the crystallized mixture, through the action of gravity the liquid portion gradually sinks and passes out at the bottom of the hogshead. This natural separation of the molasses makes a product of exquisite palatability and one of a character which it is difficult to equal even by the production of high-grade sirup. Before the Civil War this kind of molasses was used throughout the United States. At the present time only extremely small quantities of it are made inasmuch as the open kettle process is practically a lost industry in the South. The term "New Orleans molasses" as used at the present day, therefore, applies to a product of quite a different character.

Sugar Cane Molasses.—Since the introduction of modern processes of making sugar, namely the vacuum pan and centrifugal process, the character of molasses from the sugar cane factory has constantly deteriorated. This is a natural deterioration due to the improvement in the method of sugar making. Much larger quantities of sugar are now obtained in a crystallized state than formerly. The molasses is to this extent impoverished and the impurities contained therein increased proportionately. It is quite common now in the process of manufacture of sugar from sugar cane to secure at least three crystallizations.

First Molasses.—When the sugar is crystallized in the vacuum pans and separated from the molasses in the centrifugal the product which is obtained is called "first molasses." Usually this molasses is diluted to a sirup and reboiled in connection with the clarified juices direct from the sugar cane and thus a second portion of sugar is obtained or the molasses may be boiled separately and a second crystallization of the sugar separated by the centrifugal. The molasses from this product is called "*second molasses*" and is inferior in quality to the first molasses.

Third Molasses.—The second molasses is reboiled to a thick consistency, placed in wagons, and transferred to a warm room where it is allowed to remain, sometimes for two or three months, when a third crystallization takes place. The sugar from this crystallization is separated as usual by the centrifugal, and a third molasses produced of still greater inferiority. Thus, in the best sugar factories high-grade molasses is not made in the United States but only that of inferior quality. This molasses is largely used for fermentation, or is fed to the mules on the plantations. It is also employed to a certain extent for mixing purposes as indicated above.

Analysis of First, Second, and Third Molasses.—

Grades.	Total Solids.	Sucrose.	Dextrose.	Levulose.	Ash.	Albuminoids.	Amids.	Acids and Gums.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
First,	80.00	53.60	8.76	8.00	4.00	0.20	0.94	4.50
Second,	80.00	41.70	12.20	12.50	5.35	0.25	1.50	6.50
Third,	80.00	31.70	15.00	16.50	6.30	0.30	2.00	8.20

The increasing content of dextrose and levulose, of ash, acids, and gums, and the decreasing content of sucrose or pure sugar are characteristic of the second and third molasses.

The above analyses show the progressive change in molasses due to the separation of the successive portions of sugar and indicate the lowering of the quality of the molasses, at least for food purposes, as the separation of the sugar becomes more complete. It is evident that in the manufacture of sugar in this way, in which very probably an effort is made to get the highest possible yield, the resulting final molasses is a substance quite unfit for human consumption.

Sugar-house Molasses.—Attention has already been called to the production of sugar-house molasses or sugar refinery molasses. This is a product which in its physical appearance is far superior to the third molasses of the sugar factory and this superiority is due to the fact that all suspended matter in the refined molasses has been removed by filtration. In so far as soluble materials which are not food is concerned, however, the refinery molasses contains even larger proportions than the sugar factory molasses. The refinery molasses is not usually considered suitable for food except when diluted as has been before indicated in the way of mixing sirup.

Mixed Sirups.—By far the greater part of the sirups used in the United States are mixtures of two or more saccharine substances. The glucose of commerce is the base and perhaps chief constituent of the most of these mixtures. The glucose, being colorless and of a thick body, forms an ideal base as far as physical properties are concerned, for a table sirup. The quantity used varies very largely, but in general the glucose constitutes by far the larger percentage of the mixed product. Since glucose has only a very slightly sweet taste and is devoid of the general palatable properties which make a sirup attractive, it is colored and flavored with the product of the sugar cane or the maple tree. Sorghum sirup is also used very extensively in mixing. The process of mixing is an extremely simple one. The glucose is warmed until it is easily workable and the added sirups or molasses which are used for coloring and flavoring mixed intimately with it. In large factories this is done by mechanical mixers while in a small way it may be done by hand. Instead of glucose, one sirup itself may be used as the base and mixed with another for flavor, as, for instance, in the case of mixed maple sirup. Very commonly the brown sugar is melted with water and this is used as a base for the formation of sirups. Whichever may be the case the principle of the process remains the same, namely, using as the base a cheaper and less palatable material and flavoring and coloring with the more expensive and more palatable material. From a dietetic and commercial point of view there can be no valid objection raised to this method of mixing sirups. The product is, as a rule, attractive, palatable, and wholesome.

Attention has already been called to the fact that the final molasses in the sugar refinery, after all the sugar has been extracted that can possibly be gotten out by the most approved modern process, is used very extensively for mixing purposes. This molasses has a very high content of soluble salts, reaching often 8 percent or more, which give a distinct flavor and character. It also has acquired a certain flavor quite distinct from cane sirup, which gives it a peculiar value as a flavoring agent. It is commonly known as "refiner's sirup" and is a clear product, free from suspended matter by reason of its repeated filtration. It can thus be mixed with glucose and forms a bright mixture, devoid of suspended matter and turbidity, and is attractive to the eye. Ten percent of molasses of this kind added to a glucose will make a mixture which is attractive and salable, the objectionable qualities of each ingredient being obscured. The other products which are used for mixing with the glucose in the manufacture of table sirup consist of the molasses obtained from cane sugar factories or the sirups made directly from the sugar cane and sorghum. All these bodies have valuable mixing properties and small quantities of them give sufficient color and flavor to the mixed product.

Adulteration of Mixed Sirups.—The adulteration of mixed sirups consists chiefly of adulterations that are in the materials from which they are made. Glucose itself often contains sulfurous acid used for bleaching in the process of manufacture. It also contains considerable quantities of sulfate or chlorid of lime incident to its manufacture and coming from the sulfuric or hydrochloric acid used in the hydrolysis of the starch from which it is made. The molasses which is used for coloring and flavoring may also contain injurious substances. For instance, sulfurous acid is very extensively used in the manufacture of cane sugar and this acid becomes concentrated in the molasses. Lime is used very extensively in the clarification of the juices and this lime is not wholly separated but some of it is concentrated in the molasses. A moderate amount of lime, however, is not objectionable. Salts of tin are frequently employed in washing the sugar in a centrifugal and these salts are found concentrated in the molasses. The excess of bluing which is used in the centrifugal is also found in the molasses. Various forms of acid phosphates are frequently employed in the clarifying of the cane juices and a part of these is also found concentrated in the molasses. In fact the molasses from sugar cane factories very frequently contains such quantities of these added substances as to render it unfit for human consumption. It is true that these substances are diluted when mixed with glucose, but this is not a sufficient excuse to warrant their employment. It is possible to obtain unobjectionable sirups and molasses for mixing purposes and manufacturers should be held strictly to account if this is not done. In so far as has come to my knowledge there are no adulterants directly added to the mixed sirups except for bleaching purposes.

Attention should be called, however, to still another form of adulteration due to the fact that the molasses from the sugar cane factories is often so dark-colored as to be even unfit for mixing.

In such cases it is not uncommon to bleach the molasses by adding zinc and acid producing nascent hydrogen and leaving the salts of zinc, either the sulfite or chlorid as the case may be, in the product. Molasses containing salts of any of these heavy metals, namely, zinc, tin, or lead, should be rigidly excluded from consumption.

General Observations.—If a sirup is to be considered in the light of the definitions already given, as the result of evaporation, after proper clarification of the saccharine juices of sugar-producing plants it is doubtful if the term should be used in connection with the mixed products which have been described. I have used it because these are the commercial designations. Since molasses is also used very extensively in the manufacture of these mixed sirups it might be asked if they could not also be as properly called molasses as sirup. In England the material which is called molasses in this country is usually known as treacle and the very dark molasses coming from the refinery or the sugar factory is known in both countries as "black strap." If molasses be concentrated to a high degree and pulled while cooling the product is known as taffy in this country or toffy in England,—it is also known as molasses candy.

The general conclusion in regard to this matter is that since the processes of sugar making have been so improved as to extract the greater part of the crystallizable sugar, thus concentrating the residue of an inedible character in the molasses and since, further, the use of various chemicals in the clarifying of sugar juices has become general, all of which are practically concentrated in the molasses, this latter product has practically ceased to be edible.

The laws relating to the distillation of alcohol have been so amended as to permit the production of industrial alcohol, under conditions prescribed by the Commissioner of Internal Revenue, free of tax. Molasses is an excellent material for this purpose and, in addition to this, is the cheapest material which can be used. The obvious inference is that this material should be used exclusively for the production of industrial alcohol or for some other technical uses and no longer be prepared for human food. The production of straight, pure sirups from maple sap and the sap of the sugar cane and of sorghum and, in certain conditions, from sugar, can be easily secured in quantities sufficient to supply the demand not only for the consumption of pure sirups but also for supplying the materials which when mixed with pure glucose produce the mixed sirups of commerce. Thus inedible molasses would be eliminated from human food and mixed sirups be rendered unobjectionable articles of diet.

CONFECTIONERY.

The term confectionery is applied to a wide range of products which may in general be described as preparations of saccharine substances with various colors and flavors. A common appellation used in connection with confectionery and one which describes perhaps the major part of the product is the term "candy."

Material Used in the Preparation of Confectionery.—The saccharine materials which are employed in the preparation of confectionery are sugars of various kinds, namely, maple, cane, and beet sugar together with glucose, dextrose, and invert sugar. Starch, which is not a saccharine substance, is sometimes used as a filler in some forms of confectionery. The colors used are either those of a vegetable character, such as saffron and annatto, or those derived from animal substances, such as cochineal, or in many cases that large class of bodies derived from coal tar and generally known under the name of anilin dyes. The flavors employed are either natural flavors, such as those derived from nuts and fruits, or their preparations, extracts, such as the extract of vanilla, and synthetic preparations, including a very large number of artificial flavoring materials resembling to a greater or less degree the natural flavor of fruits, nuts, or flowers. Chocolate is one of the most common and one of the most highly appreciated flavoring reagents employed, being largely mixed with sugar before using. Not to be included in the permissible materials in the manufacture of confectionery are any powdered mineral substances or mineral substances of any kind (except such as are incident to the manufacture of the product as the natural constituents of the raw material), poisonous or harmful colors or flavors, and fermented, vinous, and distilled liquors and drugs of all kinds.

Under adulterations the question of what is harmful or hurtful in such material will be more fully discussed.

Method of Manufacture.—Each manufacturer has his own method of mixing, flavoring, and coloring his products and these are mostly trade secrets. A general statement, however, may be made regarding the method of procedure. The saccharine substances are usually dissolved in water and brought to the proper consistency by heating. The colors and flavors are added during such part of the process as is most favorable to their incorporation and retention. The mass, when of the proper consistence, is molded into the various forms in which candies are found in commerce and in many cases polished in revolving drums of copper or other polishing device. It would be useless to undertake, even if they were known, to describe the manifold methods employed to secure the fancy and high-class confections which are found upon the market.

Crystallized Fruits and Flowers.—When fruits and flowers are treated with sugar sirup which is subsequently allowed to crystallize there are produced what is known as candied or crystallized flowers or fruit. These substances in this case become confections and should be judged by the same standards as the straight candy.

Food Value of Candy.—The food value of confectionery or candy is not as a rule considered, since it is eaten more for its flavor and general palatability and attractiveness than for its nutritive properties. Nevertheless, the food value of candy is often very high and is measured chiefly by the sugars it contains.

Adulteration of Confections.—The question of adulteration of confectionery is one which is somewhat difficult to discuss, since in the definition of confectionery and candies the incorporation of added harmless colors and flavors is regarded as a legitimate process. It is evident that because a confection is colored or flavored there is no reason for the statement that it is adulterated. Confections not being a natural product their coloring and flavoring cannot be regarded as deceptive since neither process can be used in any sense to deceive the purchaser. It follows, therefore, that any kind of a harmless coloring or flavoring material will be a legitimate addition to confectionery. The question, however, of what is harmful or harmless is one difficult to decide. The manufacturer of coloring and flavoring materials and the manufacturer of confectionery are always quite ready to certify that the colors and flavors used are harmless to health. On the other hand the physiological chemist, who stands apart from the commercial point of view, may be led with difficulty to adopt the same conclusions. It is evident there are some colors, especially those of a vegetable character, which must be regarded as harmless. Nearly all vegetables contain natural coloring materials, either chlorophyll or derivatives therefrom, which are, without doubt, quite harmless. The addition of coloring matter of a vegetable character to confectionery is not regarded as in any way a harmful or deleterious ingredient to the product. The same may be said of animal coloring matter, since there are also natural constituents of animal substances used such as cochineal, which, as is well known, is derived from an insect, and hence the addition of such a substance to a food product may be regarded in the present light of our knowledge as harmless. There are also synthetical preparations which from a chemical point of view, and in so far as known from the physical point of view, are closely identified with vegetable substances. These preparations may, *a priori*, be regarded as substances not injurious to health. On the other hand almost the whole range of mineral colors which formerly were so much used in tinctorial art, namely, the oxids and salts of metals such as copper, chromium, lead, arsenic, etc., are regarded by practically all authorities as injurious substances and not suitable for introduction into food products. There is left then for consideration in this respect that vast body of coloring matters derived from coal tar and known in general as anilin dyes, whether directly made from anilin or not. On the question of wholesomeness of these bodies there is much division of opinion. Of the many which are known, however, only a few are regarded as harmless. Perhaps thirty different dyes would cover the whole number which have been pronounced harmless by expert observers. The experts, however, who have rendered decisions in this matter do not agree as to the harmlessness of the list just mentioned. Some of them include some portions of the list and exclude others from their commendation. It so happens, therefore, that only a few so-called anilin dyes have really escaped condemnation at the hands of some of the experts. The general character of anilin dyes and the well known poisonous property of the radical from which they are derived leads to the supposition that it would be very unsafe in any case to make an absolute statement in favor of any of them. These bodies, as a rule, undergo no change in the metabolic processes. They pass in and through the cellular tissues of the body and are excreted mostly in the urine and hence place a burden upon the excretory cells which, although light, is unnecessary. The possibility, too, might be taken into consideration of a direct toxic effect which they may exert although in a minute degree upon the cell structures through which they pass. It is certain that these bodies can exert no beneficial effect upon the structure of the cells and it is hardly likely, in the doctrine of probabilities, that they should be neutral. It is advisable, therefore, to suggest to the manufacturer of confectionery as well as of the other food products, but of confections in particular, the wisdom of seeking some method of producing attractive colors in their products among sources which are open to no suspicion. It might be that this would be attended with some expense and that the dyes which are unobjectionable may be more costly. This, however, should be a matter of very small consideration to the manufacturer who has the welfare of the public at heart. The price of confectionery, as is well known, is out of proportion to the prices of the raw materials of which it is made. The quantity of coloring matter which confections contain is acknowledged to be minute so that whether the colors cost a dollar or five dollars a pound makes little difference in the actual cost of the product and the highest priced colors would not diminish the percentage of profit to any noticeable degree.

Aside from the use of harmful colors and flavors, which are always to be regarded as adulterants, there are many other practices in connection with the manufacture of confections that may be classed as objectionable. Most of these have, however, been forbidden by law in the states and in other countries and are now forbidden by our national law. The addition of ground mineral matter was long known as one of the principal adulterations of confectionery. This, in my opinion, is no longer practiced in the United States. The substances used were commonly known as terra alba, that is, ground talc, powdered silicates, powdered chalk, or ground marble—in fact any white powdered mineral substance. The object of this adulteration is manifestly to increase the weight.

Poisonous Mineral Colors.—In the early days of the manufacturing of confectionery salts of lead and compounds of chromium, as well as compounds of other metals such as copper, etc., were employed for coloring purposes. The use of these bodies is now extremely rare, however, if it is ever practiced, and hence may be regarded as a practice of the past.

Glucose Containing Harmful Substances.—The bleaching of glucose by sulfurous acid naturally leads to the introduction into candies of this substance. It is present in minute quantities, however, and if the glucose is carefully made, I may add, in negligible quantities. The danger of oversulfuring must not be forgotten and it is difficult to draw a line of demarkation between what may be regarded as negligible and injurious quantities. The abandonment, therefore, of the use of sulfur must be regarded as the only safe way of protecting the consumer against an adulteration of this kind. The use of poisonous flavoring is perhaps more extensive than is generally recognized, especially of that flavor which is supposed to be characteristic of the kernel of the peach, namely, benzaldehyde or its derivatives. There is also a small amount of hydrocyanic acid in the kernels of the peach, almond, etc. This is a very deadly substance and no artificial preparation of it should ever be used. If there be any flavor of this kind in a confection it should be derived solely from the almond or similar nuts which contain only minute traces. While nature, as is well known, places poisonous substances in many food products, they have been so skilfully combined as to render their effect the least harmful. When man produces a similar poisonous article artificially and adds it to a food, the poisonous effect thereof is undoubtedly increased. Hence the use of artificial harmful flavors of any kind in a food product, especially confectionery, is utterly reprehensible and unpardonable.

Alcohol.—Alcohol has been placed in different forms in confectionery, sometimes enclosed as drops within the saccharine substance. This must be regarded as an adulteration of a very reprehensible character, since these products are eaten so much by children and the danger of injury from the alcohol and the danger of forming a habit from eating it in this way is extremely great. This form of adulteration is specifically forbidden by the national law. In view of the fact that children and young persons of both sexes, and especially girls, eat confectionery so largely it is incumbent upon every manufacturer to see that no raw material is employed in his processes and no flavoring or coloring or other added ingredient used which is in any way under suspicion as being a harmful or deleterious substance. Manufacturers should remember that a mere certificate of purity from the person making these substances is generally of little value. Even if the statements made in such certificates are true they will always be under suspicion, because it would be supposed that they were made for the purpose of furthering trade rather than for the protection of the consumer. In the case of two experts of like honesty and like industry, one employed for the purpose of giving a certificate to the article of food and one whose researches are entirely independent of any commercial relations, the public will generally give the decision of the latter a greater weight. Inspection officers under state and national food and drug acts should give especial attention to the subject of confectionery as an article of diet almost universally employed and consumed by a class of the community most susceptible to injury.

HONEY.

Honey is defined as the nectar of flowers, gathered and stored by the honey bee (*Apis melifica*). While this is a very good definition there is often found in honey saccharine exudations of the plant other than the nectar of flowers. Many plants contain sugar in their saps and when an exudation of sap takes place and the water in the sap is evaporated a saccharine residue remains which is also gathered by the bee. Many trees, especially of the pine family, exude a sweet sap when stung by a kind of louse (aphis) and this is also gathered by the bees. Thus while there may be other exudations of the plant found in honey the fact remains that the true honey is gathered exclusively from the nectar of the flowering plant. A honey which is made by feeding bees sugar sirup or other artificial sugar food cannot be regarded as a genuine article. The feeding of bees, while a strictly legitimate practice, should be confined to keeping them over periods of famine or the keeping of them alive during the winter or at other times when they do not have access to the flowering plant.

Historical.—Honey has been used by man for food from the remotest antiquity. In fact, in earlier times honey was the only sugar substance at the disposition of man. He had not yet learned the sources of great supply which now are at his command or if he had he was not familiar with the technical processes of preparing the commercial article. Honey is approximately a pure saccharine substance and this, in addition to its peculiar and, to most people, pleasant flavor, not only gave it a vogue in the earlier times of necessity but has maintained it in public favor when other and cheaper sources of saccharine substances have been developed. In fact, at the present time it might be said that honey owes its value upon the market not to the fact that it is a saccharine body but that it contains flavors and aromas im-

FIG. 83.—SWARM OF BEES ON BOUGH OF TREE.—(*Courtesy A. I. Root Co.*)

parted to it by the flower and by the bee which render it a luxury rather than a necessity of life.

Preparation of Honey.—While bees stored their honey in hollow trees or other suitable places in earlier times this was a doubtful source of supply. The bee tree is still an object of interest in every neighborhood. Many wild animals, especially bears, are very fond of honey and these animals were the robbers of the honey bee in the days when wild beasts roamed the forests. Since the removal of the forests to such a large extent in the interest of agriculture the bee tree is becoming a curiosity rather than a matter of common occurrence. Wild swarms of bees, therefore, at the present time, find other places for building their hives than the hollows of trees. They are likely to light upon almost any point that affords them a temporary support and attempt, at least, to form a colony. Unless, however, they have some natural protection such as that of a hollow tree, these attempts are usually unsuccessful. In Fig. 83 is shown a swarm of bees, which, gathering on the bough of a tree, have bent it to the ground.

FIG. 84.—ARTIFICIAL BEE HIVES UNDER SHADE OF GRAPE VINE.—(*Courtesy of A. I. Root Co.*)

Artificial Hives.—The artificial hive has now become an inseparable incident in bee culture. The various forms of hives and their relative merits cannot be discussed in this manual. There are many special works on bee culture in which all these mechanical appliances, which are so favorable to the storing of large quantities of honey, are described. The most approved form is that which permits the depositing of the combs in small boxes which when filled usually weigh about one pound and which can be easily removed from the comb and are in a condition to send to market. The proper method of locating bee hives is indicated in Fig. 84.

The art of bee keeping is not easily acquired and it requires a natural aptitude as well as long study and research to become an expert bee keeper. Experts differ in their opinion respecting the relative value of hives, and rival manufacturers also do much in the way of advertising one or another of these contrivances. All of them that have merits are such as protect the bee, during the months when it is idle, from starvation and disease and afford it every possible facility for storing its treasures during the season of activity.

Distribution of the Honey-producing Industry.—Every part of the United States is suitable in some respects for the production of honey. Naturally the extreme northern portion, where the winters are very severe, are less favorable than the southern portion for two reasons, first, the difficulty of

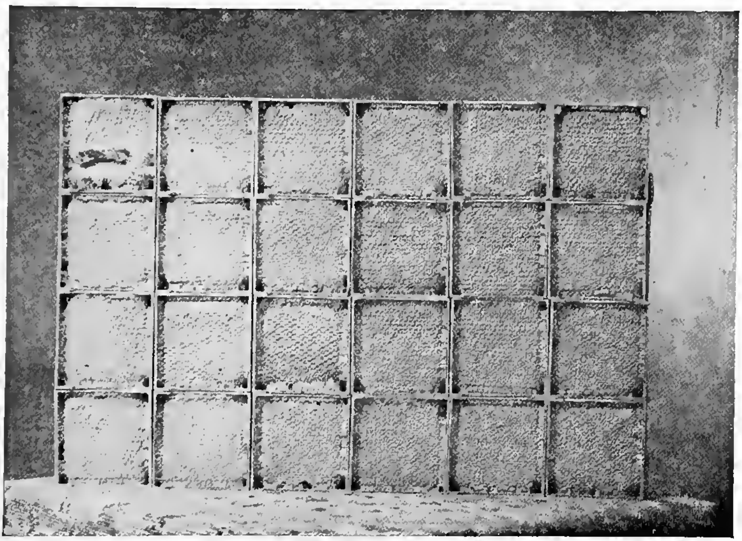


FIG. 85.—A FRAME CONTAINING 24 BOXES OF HONEY.—(*Courtesy A. I. Root Co.*)

keeping the bees over the winter is greater in the North, and, second, the season of activity is much shorter. On the other hand the honey which is gathered from the northern flowers is, as a rule, more highly prized than that gathered from the more southern regions. California, perhaps, is the greatest honey-producing state in the Union, though portions of New Hampshire, Pennsylvania, Ohio, and many other states have developed great industries. It is very common also for the farmer to have a number of bee hives, particularly for storing honey for domestic consumption, so that the making of honey is almost as common on the farm as the making of butter.

Comb Honey.—The honey which is produced in the hives and removed without extracting it from the comb is known as "comb honey." As indicated above, at the present time large amounts of this product are made by the filling of small boxes of a size intended for the market. This is, by far, the most convenient method of handling the product. A frame showing 24 boxes of comb honey as withdrawn from the hive is illustrated in Fig. 85. It has also the additional merit of a practical guarantee of the product. In Fig. 86 is seen a box of honey in which the capping is incomplete. Many mechanical attempts have been made to imitate the genuine comb and in many respects a certain degree of success has been attained. In fact nearly all of the commercial comb honey of the present day is made in combs built upon an artificial base in which the cells of the comb are started and sometimes built to a considerable depth. The bee is then only required to fill out the remaining portion of the cell and, after filling it with honey, to cover it over. Thus

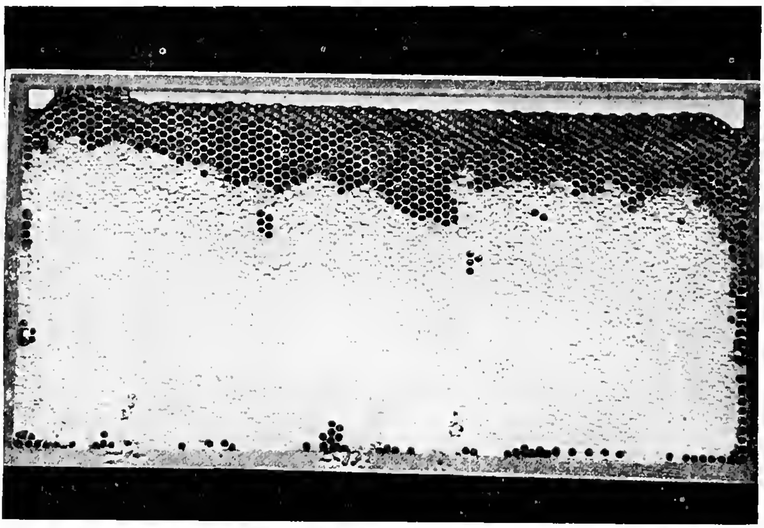


FIG. 86.—SHOWING BOX OF HONEY PARTIALLY CAPPED.—(*Courtesy A. I. Root Co.*)

the labor of the bee is greatly diminished in respect of comb building and its energies preserved for a greater production of honey. It must be admitted that honey preserved in the comb has a delicacy and daintiness which does not attach to that which has been separated and sold in a liquid form. The comb honey, therefore, commands a fancy price.

Extracted Honey.—Where honey is to be shipped to any great distance it is found difficult, if not impossible, to transport it in the comb, since the jarring and exposure incident to transit break the delicate cells and allow the honey to escape. For commercial purposes, therefore, especially when honey is to be shipped to distant points, it is separated from the comb at the place of manufacture. The usual method of separation is by centrifugal force. The caps of the cells being removed, the boxes which contain them are placed in a centrifugal machine and the honey forced out by centrifugal action. The boxes are then returned to the hives where they are refilled by the bees. By this process extracted honey can be made in great quantities and for a much lower price than the same quantity of honey still held in the combs. The principal objection to extracted honey is due to the fact that it has been subjected to such extensive adulterations as will be mentioned further on. There can be no valid objection made to the character of extracted honey when it has been prepared under competent direction and with the skill and care which are required by the professional honey makers.

Strained Honey.—Strained honey is a variety of extracted honey which is allowed to flow by gravity or by gentle pressure from the broken or fragmentary combs. In such cases, naturally, the cell or honey comb is destroyed. The residual comb is sent to market as beeswax.

Properties of Honey.—Honey at ordinary temperature is a viscous liquid of a tint varying from almost colorless to almost black, according to the character of the flowers and the season in which it is gathered and the length of time of storage. It contains from 15 to 25 percent of water and usually has a small quantity of foreign substances, incident to its manufacture, such as particles of dust, pollen, fragments of bees, fragments of comb, etc. Honey, therefore, is a somewhat concentrated solution of sugars and these sugars are the natural products of the flowers of plants, modified to some extent, by passing through the organism of the bee. In passage through the bee the honey is impregnated with a small quantity of an acid, named from the ant, formic acid. It also suffers other changes which are very strongly marked in flavor and aroma but which cannot be very readily traced chemically.

Polarization.—Pure honey, that is, honey gathered solely from the saccharine exudations of flowers, at the ordinary temperature of the laboratory, namely, from 65 to 85 degrees F., has the faculty of turning a plane of polarized light to the left, which is just the opposite of the optical properties of cane sugar. Whenever a honey shows a right-handed polarization it is a cause for suspicion respecting its purity. A honey of this kind has either been made by feeding the bees a sugar sirup or by the gathering, on the part of the bees, of the saccharine exudation, before alluded to, known as honey dew. It is perfectly true that bees may have gathered in exceptional cases exudations of plants which will show a right-handed polarization, but this occurs so infrequently as to render it advisable to regard such a honey as abnormal in quality. The polariscope, therefore, becomes an almost indispensable implement in a study of the purity of honey.

Water.—As has already been stated, the usual content of water in honey is from 15 to 25 percent. It very rarely falls below 15 percent and also very rarely goes above 20 percent. In extremely dry periods it is evident that the content of water becomes less, while in times of rain or at the first advent of the flowers the content of water will be greater. The bee naturally modifies to some extent the content of water in order that the organism may dispose of the product. If the content of water is too small the bee handles the product with difficulty and if the content of water is too large difficulty in gathering and storing the honey on account of the excessive fluidity is experienced. As before intimated, the color of the honey depends largely upon the flower from which it is made. White clover gives a honey almost water-white and among all the honey-producing flowers is perhaps regarded the most highly. On the other hand a plant like the golden rod, which flowers later in the summer, produces honey of a deep yellow and sometimes almost a black tint. The color of honey, therefore, indicates not only the season of the year at which it is stored, becoming darker as the autumn advances, but also the nature of the flower from which it is produced.

Ash.—The content of mineral matter in honey is extremely small and perhaps is largely due to the mechanical entanglement of dust in the nectar rather than the exudation of actual mineral matter itself from the flower. In some cases the amount of mineral matter is so small as to become a mere trace while in other cases it has been found as high as .3 of one percent. A high content of ash denotes the exposure of the nectar previous to gathering to an infection of dust or to some other abnormal condition. A high ash content, therefore, always indicates that further study should be made respecting the purity of the product.

Sucrose.—The amount of sugar (cane sugar) which is found in honey is in normal conditions not very large, but in exceptional cases the sugar content, that is, the sucrose content, may reach as high as 8 or 10 percent. At such times the honey has only a slightly left-handed polarization or may become right-handed. Whenever the content of sucrose in honey reaches as high as 8 percent there is ground for suspicion that the bees have been fed on sugar sirup, or that some other form of adulteration has been practiced.

Dextrose and Levulose.—The two principal saccharine components of honey are the sugars known as dextrose and levulose, in other words, taken together, inverted sugar, that is, sugar made by the inversion of cane sugar or sucrose. In the nectar of flowers these two sugars exist almost in the proportion which would be expected if they had been formed from sucrose or ordinary sugar by a simple chemical process. Sometimes one of these sugars and sometimes the other may be in slight excess. The names of these two sugars indicate their active properties. Dextrose is a right-handed sugar, that is, it turns the plane of polarization to the right. In this respect it resembles sucrose or ordinary cane sugar, although it is not so strongly right-handed. Levulose, as the name implies, is a sugar which turns the plane of polarization to the left. The temperature of the solution has a very marked influence upon this active property,—the lower the temperature the greater the left-handed rotation. A honey which has a strong left-handed polarization, therefore, at ordinary temperature is one in which the levulose is present in full proportion or very slight excess. The other constituents of honey, namely, the pollen which is mechanically entangled therein, the dust or dirt which is mechanically attached thereto, the formic acid imparted thereto by the bee, and the other ingredients, are extremely minute in quantity and are not, as a rule, expressed as percentage constituents. In fact the most of them are merely accidental constituents.

Adulteration of Honey.—Perhaps there is no common food product, with the possible exception of condimental substances such as pepper and spices, that has been subjected to such extensive and general adulterations as honey.

The high price of honey, its position as a luxury as well as a food product, and its attractive flavor and aroma have all combined to make it a favorite product for adulteration. In addition to this the invention in the last third of a century of an artificial product resembling honey very closely in its physical properties and being itself a saccharine body, namely glucose, has put into the hands of the adulterator an ideal substitute for the natural product. There is only one reason why the adulteration of honey with glucose has not been more extensive than it is, namely, the ease with which the chemist can detect it. The chemical properties of glucose are very distinct from those of honey itself. In spite of this fact, however, the adulteration of honey has been most extensively exploited and until the methods of detecting it were developed it was almost universally practiced. Glucose is a water-white saccharine semi-viscous mass made by the hydrolysis of starch with an acid and therefore forms the body upon which the adulterated article can be built. It has a low saccharine value and cannot be used alone but must necessarily be mingled with the honey. The amount of real honey used is, as a rule, a minimum to give the flavor and taste of the genuine article to the admixture. It is believed at the present time that this method of adulterating honey is very much less practiced than in former years and this is due, as has been said, to the ease with which it can be detected and also, it may be added, to the increased rigidity of national, state, and municipal inspection, rendering it difficult to place an adulterated article such as this upon the market without detection. Incalculable harm has been done to the honey trade of the country by the practice of this style of adulteration. Only liquid honey, that is separated or strained, can be easily adulterated with glucose. Often, however, an attempt has been made to still further deceive the customer by placing a portion of the genuine comb honey in a jar and then filling it with the adulterated mixture, giving the appearance of the genuine article to a certain extent to the whole.

Adulteration with Inverted Sugar.—A much more subtle form of adulteration, and therefore one much more difficult to detect, is the adulteration of honey with a sirup made from inverted sugar, that is, the product obtained from cane sugar by the action of a dilute acid. This chemical process, as has already been indicated, converts the cane sugar into a mixture of dextrose and levulose. These sugars are identical, for chemical purposes, with the natural dextrose and levulose of honey. The chemist, therefore, has a much more difficult task to perform when he attempts to diagnose the presence of artificial dextrose and levulose in a mixture of the natural product. There are, however, certain qualities of ash, as well as other chemical constituents, which guide him in his work. While his conclusions do not have that definiteness which attaches to the examination of a honey adulterated with glucose they are sufficiently distinctive in most cases to determine whether or not a sophistication has been practiced.

Adulteration with Cane Sugar.—A very simple form of adulteration and one which cannot be practiced to any extent without being easily detected is the admixture of a sirup of pure cane sugar to honey. As long as the quantity added is not sufficient to change the optical properties, so that the mixture becomes right-handed in its rotation, the admixture of a small quantity of cane sugar sirup might escape the detection of the chemist. Inasmuch, however, as cane sugar exists only in small quantities in honey the regular and persistent occurrence of much cane sugar in a honey would be a just cause for suspicion, although its occasional occurrence might be due to purely natural causes.

MISCELLANEOUS.

Mince Meat.—Under the term "mince meat" is included a large variety of mixtures used chiefly for pie making and composed of meats, fruits, evaporated fruits, spices, and sometimes alcohol in some of its forms. It is not possible to describe any particular combination which would be entitled to bear the name alone, since each housewife and each manufacturer follows a method of her and his own. A general description, however, may be given of the manufactured article which, unfortunately, has largely displaced the mince meat of domestic manufacture.

Judged by the name alone, meat of some kind would be an important constituent of this substance. This, however, is not the case. Very few of the mince meats contain more than 10 percent of meat, a large number contain less and quite a large number contain none at all. Suet and tallow are sometimes employed as a substitute for meat, which apparently satisfies the conscience of the manufacturer even if it does not suit the palate of the consumer. Evaporated fruits, such as raisins, etc., form important constituents of the mixture and also fresh fruits, in domestic manufacture, are very often used. Spices of various kinds are also employed and the mixture is sometimes flavored with brandy or some alcoholic beverage.

Pressed Mince Meat.—The mixture which is above described may be dried and pressed, or pressed without drying, into a hard firm cake which renders it more suitable for transportation and improves its keeping qualities. There is perhaps little difference between the unpressed and the pressed mince meat except in the matter of a binder. The binder consists usually of starch or flour, which serves not only to give additional weight to the mixture but also to hold the particles together. Starch or flour is sometimes used in unpressed mince meat also. There is another advantage in using starch or flour, namely, that these bodies absorb large quantities of moisture and thus increase the weight of the mixture. Mince meat cannot be recommended on sanitary grounds, since the method of manufacture is not always known and the materials from which it is made are not always selected with the sole view to the excellence of the raw materials and the health of the consumer. The meat when used often represents waste material from the table or factory and the fruits are not necessarily those which look best but probably are those usually of the worst appearance and the combinations are made with a view of meeting the ordinary demands of the market rather than of catering to the tenets of sanitation.

It is not the intention of this manual to discourage any kind of legitimate manufacturing industry, but, in view of the general character of substances of this kind, if they are to be used at all, it seems advisable that they should be made in the home, of material selected by the housewife and in a manner which requires no special treatment for its preservation, rather than to be purchased at random in the open market, made of materials of unknown origin put together by an unknown process.

Adulteration of Mince Meat.—Assuming that the materials which have been selected are wholesome, sanitary, and of fine quality, the principal adulterations to which mince meat is subjected are the addition of chemical preservatives and artificial colors. Inasmuch as mince meat is not expected to be of any very definite color the use of artificial colors is not common. On the other hand when mince meat is made in large quantities, transported long distances, and sometimes kept for a long while on the shelves of the grocery, the subject of preservation becomes a matter of serious importance. It is naturally inconvenient to preserve a mixture of this kind by sterilization, though this has been accomplished. The method of drying and pressing has already been described. This, of course, detracts somewhat from the physical appearance of the product. The common method is the addition of a chemical preservative. At the present time I believe that benzoate of soda is the one very commonly used, and it will probably continue to be so used, by most manufacturers until national and state laws or an enlightened public opinion eliminate it from food products.

Pie Fillers.—Nearly allied to mince meat in its character is a large class of substances known as pie fillers. Mince meat itself, as may be seen from the description which has been given of it, is nothing but a pie filler of a particular kind. Unfortunately the demand of the domestic cuisine is for substances prepared, or partially prepared, for immediate consumption. In this way the demand for predigested and precooked food has become a very general one and the pie filler is a legitimate effort on the part of the manufacturers to meet this growing demand. It is far easier for domestic purposes to make a pie of an already prepared material than to go to the trouble of constructing the material in the kitchen. A housewife loses sight of the fact that the fresh domestic pie is probably the only one which, for sanitary and other reasons, should be admitted to the table. As the pie fillers are as varied in character as the different kinds of pies from which they are made, no definite standard can be prescribed for them. Fruits are, naturally, the predominating constituent in these fillers and the condiments and spices used are certainly unobjectionable. If it be possible to prepare spiced fruits and keep them until used for pies there would seem to be no objection to the manufacture, long before using, of these substance in large quantities. The difficulty, however, of preserving the freshness and aroma of a fruit or other substance used for pie making is so evident as to need no particular emphasis.

Adulteration of Pie Fillers.—The common adulterations in pie fillers are artificial colors, when they are designed to represent fruit of a special character, and preservatives. The same remarks which were made respecting these bodies in mince meat apply with equal force to all kinds of pie fillers. Foods of this kind are evidently only properly made on the premises where they are consumed immediately after manufacture. The addition of artificial colors and preservatives to such substances, while apparently necessary in the present condition of trade, is wholly objectionable from every other point of view, and in such cases trade conditions should properly give way to the demands of public and private sanitation and hygiene.

In the interest of both hygiene and palatability "pie filling" should be made by the pie baker. It is not possible in an article like this to secure that perfection of cleanliness and delicacy of flavor which should be characteristic, when making large quantities of "filling" and transporting it over long distances in barrels or tubs. Make the pie filling and the pies at home.

PART X.

INFANTS' AND INVALIDS' FOODS.

Introduction.—One of the most important subjects in connection with the food supply is that of foods offered for the use of infants and invalids. In so far as the chemical composition, nutritive properties, and palatability are concerned, there is nothing which may be said in general concerning infants' and invalids' foods which may not be said with equal appropriateness of foods of all kinds. It is often necessary, however, in the case of infants and invalids, to modify certain natural foods in such a manner as to adapt them to the peculiar conditions present. It is impossible in many cases to draw the line between what may be considered an infant's food and what an invalid's food. Milk, for instance, which is the universal food of infants, is also often prescribed exclusively for invalids of adult age or for well-grown children. In the disturbances of digestion the powers of the digestive organs are so changed or depleted as to reduce the grown person practically to the condition of an infant in so far as nutrition is concerned. On the other hand, every one of the foods which is specifically prescribed for infants may also be used by grown persons, under certain conditions.

It is easy, however, to distinguish, as a class, infants' foods from the foods of invalids, although the two may overlap at some points. It may be broadly stated that nothing is an infant's food which is not milk, or does not have the chemical composition, the nutritive value, and general properties of milk. In other words, milk is the natural food of the infant, and every prepared infants' food must have its value determined principally by its approximation to the composition of the natural article. On the other hand, an invalid's food may cover the whole range of nutritive materials. It would be useless, therefore, to attempt, in a preliminary paragraph, to distinguish sharply between these two classes of foods. It will be sufficient, in the consideration of these foods, and in the study of their composition and nutritive properties, to confine the discussion of infants' food principally to milk and its substitutes, and to include other foods recommended for invalids in the section on Invalids' Foods (p. 549). This is a broad line of demarkation which will avoid confusion. To a certain extent it will be necessary in the present discussion to consider further some of the foods which have been generally discussed in the preceding parts of this manual. This is particularly true of milk, and of certain meat preparations.

INFANTS' FOODS.

GENERAL NUTRITION CONSIDERATIONS.

Good Nutrition.—A child is well nourished when it continues to grow normally; is free or nearly free from colic and other disorders of the intestinal tract; sleeps well, and is not fretful, but appears to be contented and to enjoy life. The ideal food for an infant is the milk of a healthy mother. In cases where this is not available artificial feeding must be practiced. These substitutes for mother's milk are considered in the following paragraphs. Great care should be taken not to feed infants in such a manner as to make them too fat. The infant does not need much surplus tissue.

A word of caution should be given in this respect, as many mothers think if the baby is fat and chubby that is all that is necessary. While, of course, plumpness indicates to a certain extent the vigor of digestive operations, excessive plumpness should be avoided. The child that makes a healthy but not too rapid growth, without becoming overfat at any period, is in a better condition than the one that is too fat. The pictures of chubby cherubs that often accompany advertisements of proprietary or artificial infants' foods may be very attractive, but this is not the kind of feeding that best fits the real baby for a vigorous and useful life. A healthy child should increase in weight during normal growth about one-fourth of a pound a week for the first six months of its life. A child, therefore, which gains a pound in weight in a month may be regarded as being in a very satisfactory condition in so far as nutrition and growth are concerned.

Feeding of Immature Infants.—The selection of proper food for an infant depends largely upon its health, age, and general vigor. There are certain conditions in which foods which ordinarily nourish and support the health of the child are to be avoided. Many infants at birth have a remarkably low weight, and it is considered by physicians that a baby weighing less that 4½ pounds is immature. The smallness of the child renders its nutrition extremely difficult, and even mother's milk in such cases may prove unsuitable for its nourishment. An infant of this kind must have fat, proteid, carbohydrate, salts, and water in such quantity and relative proportions as will meet the possibilities of its digestion. In each case the competent physician alone can determine the quantity and composition of food which is best suited for the purpose.

The subject of the feeding of such immature infants is well set forth by Dr. Spalding in the "Journal of the American Medical Association" for September

25, 1909, page 998. In order to avoid a deficiency or excess of food, attempts have been made to base the quantity upon the weight of the infant or its heat requirements; that is, the actual heat value of the food, or caloric value, as it is sometimes called, is made to have a certain relation to the weight of the child. In these cases it is necessary to modify the milk in a very marked manner in order to secure the proper results. The original milk must be perfectly pure and from tuberculin-free cattle, and should have a bacterial count of less than 10,000 per cubic centimeter. If additional carbohydrates are used, milk sugar or maltose is recommended. Often certain bodies, especially the chlorid of sodium and limewater, are added to improve the digestion.

If sweet milk does not meet the requirements, sour milk or buttermilk properly modified may be used. In such instances a modified milk in which the ratio of fat to protein is not more than 2 : 1 is found to be most effective. The number of calories in the food for these very weak infants may not be more than 100 a kilo of body-weight, and even this proportion can be reduced after the child grows older. In some instances, however, it is necessary to have a food with a much higher food value, *i. e.*, as much as 250 calories per kilo. The great point is to watch each case to see how the modified milk is digested. If the fat can be digested, more fat is added; or if the infant digests protein easily, a larger percentage of protein is added, while the milk sugar is usually kept constant.

Quality and Frequency of Feeding.—There can be no fixed rule for the quantity of milk which should be given to an infant. The state of health, the size of the infant, and the general environment are all important factors in this problem. It is almost impossible to establish any definite rule in regard to an infant during the first month of its life. From the fourth to the sixth week an ordinary child will consume from 600 to 1000 grams of milk daily. After the fourth month the consumption will run from 1000 to 1200 grams. These amounts are based upon experiments conducted on a large number of infants and should seldom be exceeded.

The young infant especially must be protected against too large an ingestion of food. A young baby is very apt to reject by vomiting any excess of milk which he has swallowed, and this vomiting is a very natural process and is not a symptom of disease. The slower the infant takes its food, the more likely he is to escape the disadvantages of any excess.

The number of times the child should be fed is also a variable one. During the first month of life if an infant is fed every two hours it is quite sufficient; after that the feedings may vary from six to eight times daily, up to the fourth month. After the fourth month six feedings are usually sufficient, and sometimes a smaller number. The quantity of milk taken at each feeding varies, of course, with the number of feedings, and is usually from 50 to 200 grams.

It is important that the child be frequently weighed, as the quantity of food that it needs bears a certain relation to its weight and may thus be approximately determined. Gaged upon the calorific value of the food, a child weighing 5 kilograms requires a quantity of milk representing 500 calories, or five-sevenths of a liter, or in round numbers, 700 c.c. If artificial food is used, assuming that it is as good as mother's milk, a sufficient quantity of it should be employed to supply that amount of heat.

Percentage Feeding of Infants.—A great deal of attention has been given in the last few years to what is known as the percentage feeding of infants. It may be said in regard to this matter that there are two distinct and somewhat different theories in vogue. In the United States the so-called percentage method of feeding is generally upheld by the more advanced physicians, while in Germany the system which is known as the caloric is more generally held. Naturally, both systems have their good points, and neither by itself may be said to be complete.

It is not difficult, as a rule, if the percentage composition of the food, including the quantity of fat, is known, to calculate its caloric value. The trouble, however, lies in determining exactly the percentage relations of different components of the same kind of food. The absolute heat value of the food may be said to best subserve the wants of the infant when it amounts to from 100 to 120 calories per kilogram of body-weight. As the infant grows larger, this amount may be well reduced, as, for instance, it might fall to 80 calories per kilogram at the end of the first year. It is advisable, therefore, not only to have the calorific value of the food determined per kilogram of weight, but also to know the percentages of fat, sugar, and protein in the food. Some experts claim that fat is not assimilated well by the young infant, and that its presence is often the cause of acute and chronic indigestion. If this be true, it is important that the physician who wishes to protect his patient from an undue amount of fat should know the quantity present.

One of the chief difficulties, of course, in properly modifying the percentage composition of milk is the fact that the milk itself varies so greatly, especially in its content of fat. For instance, the milk from a Jersey cow may contain two or even three times as much fat as that from a cow of the Holstein breed. Hence, any hard and fast rules for modifying milk so as to secure a definite percentage composition are of little value. Fortunately, the milk varies much more as to its content of fat than in regard to any other constituent. Hence, it may be practicable to apply stereotyped rules for modifying the content of sugar and protein, but not the fat. Fortunately, the determination of the fat is one of the easiest of all the operations in milk analysis and can be very successfully made by one who is not a chemist by means of the simple Babcock centrifugal apparatus, to be had of all dealers in dairy supplies. The best results will certainly be obtained in the feeding of infants when both the calorific value of the food and its percentage composition are taken into consideration.

Calorific Value of Milk.—In the feeding of infants the development of heat and energy is, of course, quite as important as the growth of tissue. For this purpose milks rich in fat are much more important than those rich in carbohydrates. For instance, the amount of heat and energy furnished by a unit weight of fat is more than double that supplied by the same weight of milk sugar. The calorific power of milk, therefore, depends more on its content of fat than on any other constituent. A liter of milk, approximately one quart, represents on an average a little over 700 calories. As a man at moderate work requires about 3000 calories per day, it is seen that he would need more than four liters of milk. In other words, the average man might well live and perform his ordinary activities on a gallon and a half of milk a day, considering heat and energy requirements only.

Method of Computing Calorific Value.—In order to obtain the calorific value of food when its percentage composition is known, the percentage of each element is multiplied by its respective heat value for one gram, these calorific values being well known. If, then, the total amount of food used in twenty-four hours is determined, its total calorific value is obtained by simple multiplication and addition. An illustration may serve best to show how this is accomplished. Let us assume that milk prepared, or modified, for the use of an infant has 1 percent of protein, 3 percent of fat, and 6 percent of sugar, and the total quantity of milk used in a day is 300 cubic centimeters. The calorific power of fat is expressed in round numbers for one gram by 9.3 calories; that of sugar is 4.1 calories per gram; and the calorific power of protein, inasmuch as it is not fully oxidized, may be taken at the same value, namely, 4.1 small calories per gram. The total calorific value of the food is, therefore, given in the following calculation:

$300 \times 0.03 \times 9.3 = 83.7$ calories due to fat.
$300 \times 0.01 \times 4.1 = 12.3$ calories due to protein.
$300 \times 0.06 \times 4.1 = 73.8$ calories due to sugar.

169.8 total calories in the milk ingested.

Where constant recourse is had to such calculations, it may be convenient to make a table which will give the calories at once by inspection, but this is only necessary in exceptional cases.

Dangers in Bottle Feeding.—If infants are fed by bottle or in any artificial way, great precaution must be observed to keep the bottle and all parts of the apparatus free from bacterial and other infection. This is not by any means as easily accomplished as one might suppose. The mere washing of the apparatus with hot water after feeding a child is not sufficient. Two or three times a day all parts of the bottle should be put into water gradually heated, and boiled for some time, in order to be certain that no contamination is possible. Even where the milk is good and pure the contamination of the container may be so great as to work an injury upon the child. All complicated methods of administering the milk should be rejected and the simplest one possible adopted.

Beginning of Mixed Foods.—When the first food is given, the greatest care should be exercised in regard to its quality, and especially that it shall be a food most easily digested. Reference has already been made to milk sugar and malt as probably the best of the milk modifiers that can be used. At first the solid particles of the malt should not be employed, but only those portions soluble in water. Malted cereals in small quantities may be given later on as the stomach of the child becomes able to digest them. Fruits should never be given to infants at this stage, though small quantities of properly prepared fruit juices may not be inadmissible after the child approaches the age of a year. The juice of wholesome meat in small quantities is also relished by growing children. Any foods which contain an alkaloid, such as coffee, tea, or chocolate, should be rigidly excluded from the diet. For the same reason alcohol should never be given to children even after they pass the age of infancy. Solid food which requires mastication should not be used until the child's first set of teeth are well developed, and then these articles should be administered in small quantities and the child taught to chew them as well as possible before swallowing. It is rather difficult to teach a child to chew, as the natural tendency after twelve or fifteen months of milk feeding is to swallow any solid bodies placed in its mouth as soon as possible.

If the food disagrees with the child, after it begins to take other food in addition to milk, an effort should be made to find what particular element is at fault. There are many theories advanced in regard to this matter, but a safe way is to withhold one of the elements which is most open to suspicion and see if the disorder which had been noticed is removed. By a little experimenting of this kind, in a gentle way, a more rational feeding of the infant may be secured.

Diet at Weaning.—An important part of infant feeding relates to what diet should be used immediately after weaning. The time of weaning, of course, is variable. Some authors recommend that it be done at eight or nine months. This, I think, is entirely too early. If the child is weaned at fifteen months, it is none too old, and even a longer period may be desirable at times. There are, however, many cases where earlier weaning becomes advisable and even necessary. Hence, it is well to consider just what foods are best for the weaned infant at that early period, say before the expiration of the first year. Some mothers seem to think that the first tooth of the infant shows that the time for weaning is at hand. This, undoubtedly, is a false indication, as a child cannot eat with a single tooth. The most natural period, it seems to me, would be when the first temporary teeth are fully formed; in other words, when the child has completed its "second summer." The infant then has both incisors and molars for use in mastication. When the weaning is decided upon, it should be done gradually, giving at first a small quantity of foreign food. and gradually increasing it as the quantity of mother's milk is decreased.

Use of Starchy Foods.—Some trouble may be experienced in teaching the infant to take the new foods, and this should be undertaken with patience and perseverance. Great care should be exercised in not passing too rapidly to a carbohydrate diet which is rich in starch. For this reason malted cereals perhaps are to be preferred at first to the unmalted; but at this time of life it is necessary that the power of the child's organism for converting starch be exercised, at least slightly, and hence the administration of a small amount of starch, a very small amount at the beginning, is desirable. The malted cereals could then be gradually decreased in quantity and the unmalted increased. There is no objection to thoroughly cooking the cereal in order that the starch may be as much emulsified as possible, and thus rendered more susceptible to the action of the ferments of the mouth and of the intestinal tract beyond the stomach. There is perhaps no more valuable food at this time than oatmeal cooked many hours and given in very small quantities. Most healthy children soon acquire a fondness for this diet, to which a little milk should be added. Later cream may be substituted wholly or in part for milk, but it must not be too rich. In this way, in a few weeks, or at most months, a child will gradually be weaned from the breast without having had any disagreeable experiences and without creating any unnecessary disturbance in the home.

While oatmeal is especially recommended it is by no means to be inferred that other cereals, when properly prepared, are not good. Bread and other cooked foods can be given gradually as the child's ability to masticate its food properly is increased. At first the bread should be very soft, so that even if it fails of mastication it may not irritate the stomach. As a rule, the child's appetite can be consulted, at least partially, but not always. Firmness on the part of the mother at this period is most desirable, since when a child has eaten what is known to be a sufficient quantity for its proper nutrition, no more should be given, even though the child cry for it, as it often does. There is perhaps no more dangerous habit than that of giving food to children because they cry for it. When we consider what is fed to infants in this promiscuous way, it is remarkable that the death-rate among them is not even greater than it is.

Diet During the Second Year of Life.—The infant begins to speak during its second year and is entering childhood. The quantity of food which it consumes should, of course, be gradually increased as the child grows. At this period, however, great care should be exercised to prevent the fat-forming habit, which is very apt to be acquired by some children. The moment any excessive amount of fat is developed, the food should be diminished in quantity, even at the penalty of having a crying child. Firmness on the part of the parents at this period of life will save many a pang in the future, for parent and child.

Later Feeding.—After the second year the child's tastes may be considered more, but in all cases the quantity as well as the quality of its food should be watched. Children, as a rule, are very fond of meats (including fowl, fish, etc.), and there is a tendency on their part to eat them too exclusively. While meat, in my opinion, is a legitimate article of food for a child, it should be used in moderation, and not to the exclusion of cereals and a proper amount of fruits. All fruits, however, should be given in the form of fruit juices or as cooked fruits, until the child is at least three or even four years of age. The ingestion of fruits, without proper mastication, is a frequent cause of irritation, colic, vomiting, and other digestive disturbances in children.

Difficulty of Digesting Protein.—One of the chief difficulties in the artificial nutrition of the human infant is found in the difficulty it experiences in digesting foreign protein. As is well known, protein is digested in an acid medium, and the gastric juice of the human infant has a low content of hydrochloric acid during the first few months of existence. It is evident, therefore, that in a stomach of this kind the digesting of any considerable quantity of protein, especially a foreign protein, is extremely difficult. In fact, when feeding an infant with any foreign milk, particularly that of the cow, clots of undigested protein are often found in the feces. On the other hand, the fats and the sugar of milk are much more easily digested, and the high content of milk-sugar in mother's milk shows that this substance may be easily digested even if present in proportionately large quantities. It would seem, therefore, only rational in the preparation of an artificial infant's food (that is, milk provided from other sources) to secure a milk rich in sugar and low in protein. For this reason the suggestion is well worth considering that the milk of the mare and the ass should be used as extensively as possible for infant feeding when mother's milk is not available.

There is special danger in feeding an infant which is not entirely robust a milk containing too large a content of protein. The first effect is to make curd of the milk, and these lumps of curd resist the feeble efforts of the infant's stomach at digestion, and remain to cause indigestion, nausea, and finally colic and diarrhea. Even if all digested, it would provide a plethora of protein, which might prove seriously inconvenient. The difficulty cannot be corrected by merely diluting the cow's milk with water, for while the percentage of protein might be reduced to the normal amount required, at the same time there is a proportional reduction of the percentage of milk sugar, which is already too low in cow's milk for the purposes of infant nutrition.

The Soy Bean as a Food for Infants and Children.—Of interest in connection with the difficulties of protein digestion are the investigations of Dr. Ruhräh,* of the value of the soy bean under certain disordered conditions of nutrition in which the protein of cow's milk is not assimilated. The soy bean is extensively used for food purposes in China and Japan, and has come into some prominence in this country. There is often difficulty in feeding infants, and even young children, a sufficient supply of protein in the form of milk, and the soy bean seems to offer the protein in a more digestible form. The soy bean flour, in which form it is used as a source of food, was analyzed, with the following results:

	Percent.
Protein,	44.64
Fat,	19.43
Mineral matter,	4.20
Moisture,	5.26
Crude fiber,	2.35
Cane sugar,	9.34
Non-nitrogenous extract,	14.78
Starch,	None
Reducing sugars,	None
Polarization normal weight due to optically active substance other than cane sugar (included in proteids and non-nitrogenous extract),	7.86°

The protein in the flour of the soy bean is one-third greater than that in the whole bean. This is caused by the removal of the coarse fibrous hulls, which contain little protein, during the process of grinding. It is interesting to compare the analysis given with that of a round of beef, which has the following composition in its edible part:

	Percent.
Protein,	20.3
Fat,	13.6
Moisture,	65.5

One ounce of the soy bean flour, representing 60 calories, contains about 13 grams of protein, and the flour can be used in the form of gruel or broth or in making biscuits or muffins. It can also be mixed with cereals, barley jelly, cream of wheat, and other substances. It is recommended not only for healthy children, but in cases of summer diarrheas and other forms of intestinal disturbances to which infants during their first summer are subject. Gruel is recommended in which one or two tablespoonfuls to the quart is used. As a rule, Dr. Ruhräh found that this gruel agreed well with infants, rarely causing any vomiting or increase in the diarrhea. Barley or some other cereal should be added from time to time as required. In later stages of the feeding milk may be added to the soy bean gruel with advantage. This gruel is also recommended by Dr. Ruhräh as a diluent of cows' milk. When the food is prepared from condensed milk, the soy bean is valuable, because it not only increases the protein content of the food, but apparently

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furnishes the protein in a more digestible form. If feeding is practiced according to the caloric theory, the values secured by different quantities of the soy bean meal, used in the form of gruel, are calculated as follows:

Quantities of Meal Used.	Percentage Composition.			Calories.
	Protein.	Fat.	Sugar.	
¼ oz. (1 level tablespoonful to the quart),	0.35	0.15	0.08	30
½ oz. (2 level tablespoonfuls to the quart),	0.70	0.30	0.15	60
¾ oz. (3 level tablespoonfuls to the quart),	1.0	0.45	0.23	90
1 oz. (4 level tablespoonfuls to the quart),	1.4	0.60	0.30	120
2 ozs. to the quart	2.8	1.2	0.60	240
3 ozs. to the quart,	4.2	1.8	0.90	360
4 ozs. to the quart,	5.6	2.4	1.2	480
5 ozs. to the quart,	7.0	3.0	1.5	600
6 ozs. to the quart,	8.4	3.6	1.8	720
7 ozs. to the quart,	9.8	4.2	2.1	840
8 ozs. to the quart,	11.0	4.8	2.4	960

A quart of gruel is made by boiling from 1 level tablespoonful to 8 ounces of the soy bean flour in one quart of water for fifteen minutes, adding water to make up for loss by evaporation. Salt should be added to taste. These gruels do not thicken during cooking, as they contain no starch, and readily settle on standing. This may be overcome by adding 1 to 2 heaping teaspoonfuls of barley, oat, rye or wheat flour before cooking, which will add from 0.6 to 1.2 percent starch to the gruels, and also slightly increase the percentage of protein.

MOTHER'S MILK.

The Natural Food of Infants.—It has already been stated that the natural food of the infant is mother's milk. The demands of modern society, unfortunately, have deprived the American infant, in many cases, of the food which nature intended it to have. Illness, or the idiosyncrasy or neglect of the mother, in many more cases, has taken from the infant its natural nourishment. But it is a condition rather than a theory that confronts the American infant, and often it is a choice between starvation and a modified or artificially prepared food.

Dr. Findlay, in "The Lancet" for January 8, 1910, calls attention to the fact that there are essential differences between human and cow's milk which should not be overlooked. These differences extend to all the constituents of the milk—the proteid, the whey, the sugar, and the mineral constituents. The presence of the extra amount of mineral matter in cow's milk is of special significance. Some human milks have exceptionally large quantities of mineral matter, and these have been found to be irritating to the stomach of the child, while those that contained the normal amount were easily assimilated. The good results obtained, therefore, from diluting cow's milk with water before using it as food do not come from diminishing the amount of proteid, as has been supposed generally, but from the reduction in the proportion of the inorganic salts. The salts of sodium, especially, when given to children, are very disturbing, inducing usually a rise in temperature and an increase in the electrical excitability of the muscles. On the other hand, calcium salts have the opposite effects. The difference in salt content alone does not explain altogether the superiority of human milk, since the mineral matters of human milk, if separated and given independently to the infants, produce irritating results. Apparently human milk contains some beneficial organic substances not well understood in which the mineral matters form an active constituent, and which are destroyed in their separation from the milk. The general conclusion of the investigations is that we do not yet fully understand the secret of the beneficial effects of human milk, but that it probably is due to some essential and probably organic substance of the nature of which we are at present entirely ignorant.

Variation in Character and Quantity of Mother's Milk.—During its prenatal life the child has been supported solely by the blood of the mother. In its first days of infant life it takes but little nourishment, and that is of a rather extraordinary character. The mother's milk, at the time of the birth of the offspring, as is the case with the milk of all mammals, is not normal. In fact, it is not milk at all, but is a thick fluid called colostrum, which has quite a different chemical composition from normal milk; there is no doubt, however, that it is the normal food of the child during the first hours of its existence. It is generally supposed that the mother secretes the greatest amount of milk at the time of birth. This, however, is not the case. The amount of milk secreted by a healthy mother increases very rapidly during the first period of the child's growth, and reaches a maximum about the time the child requires the largest amount. It then begins to decline as the child may be fed with other things until the weaning period arrives. The mother's milk usually reaches a quite constant composition after about the third week, and after this period contains the following ingredients in about the percentages named:

	Percent.
Protein,	1.0–1.5
Fat,	3.5–4.0
Sugar,	6.5–7.0
Mineral substances,	0.2
Organic substances,	0.6

Variation in Fat Content of Mother's Milk.—It is evident from the analytical data which have been collected that the composition of mother's milk varies quite as much as that of other mammals, and that even in the natural feeding of an infant from the mother's breast conditions often arise which are inimical to the child's health. These conditions are due both to the variations which take place in the milk of the mother, changing the relative constituents or character of the various ingredients, and to the varying vitality of the child. Dr. Tayler-Jones, in an article in the "Archives of Pediatrics," treats particularly of the variation of the fat percentage as a factor in feeding. Dr. Jones draws the following conclusions from the results of her studies:

1. The importance of mother's milk cannot be overestimated. A physician should feel that he is taking the baby's life in his hands in lightly changing from breast milk and should so impress the mother. Besides the immediate danger, which at times is not so great, it lessens the stamina for later years. A right start in anything is essential, but nothing is more important than a right start in life.

2. If there is some disturbance to the nursing infant, the breast milk should be examined, unless some cause, like tuberculosis, is at once recognized. It is not long since patients were pronounced anemic upon looking at them, but to-day the hemoglobin must be estimated. So must it be with the breast milk.

3. Fat is an important factor if only for its variability.

4. The importance of the fats has increased lately since the Breslau investigators gave them such an important rôle in infantile atrophy (marasmus).

5. For the most part fat gradually increases in amount from the beginning to the end of a feeding, with occasionally a dip down at the end. As yet there is no proof that the increase is arithmetical. A baby that needs more fat than it is getting can easily be put to the breast after some milk has been pumped out.

6. A fat percentage, within a few tenths of a percent of the average, may be obtained by taking equal specimens from the beginning and end of the feeding and examining the mixture. This is entirely practicable clinically and should be done.

Addition of Alcohol in Beverages to the Diet of Mothers.—It is popularly believed in many countries where fermented beverages are commonly consumed that the addition of wine or beer to the diet of the mother is beneficial, improving the quality of the milk and also sustaining the strength of the mother for her extra duties. The use of alcohol in moderate quantities does not give rise to the presence of any alcohol whatever in the milk. Presumably, the whole of the alcohol is burned in the mother's body, or at least it does not enter the secretion of the mammary glands; hence there is no danger usually of administering alcohol to the child by giving it to the mother. It is doubtless true that the character of the mother's milk may be somewhat modified by the use of alcoholic beverages or alcoholic malt extracts. Experiments have shown that an alcoholic beverage tends perhaps to increase the fat, and to a less extent the protein. While it is true that physicians, as a rule, are very loath to recommend that the mother drink a fermented beverage, there are some cases of ill health in which such advice has been given and followed with benefit, especially if the mother, before the birth of the child, has been in the habit of using a moderate amount of alcoholic beverages. In such cases perhaps it is not advisable to prohibit entirely the use of these articles during the period of lactation. On the other hand, those who have not been accustomed to the use of alcohol may find that there is danger of its administration proving deleterious both to the mother and to the child. The safest way is to get along without such beverages.

The Effect of Worry or Excitement on the Mother's Milk.—Any sudden trouble or shock which produces excitement or suffering in the mother is apt to induce very radical changes in both the character and quantity of milk. These changes are of such a nature often as to interfere with the nutrition of the child. For this reason a nursing mother should be kept as free as possible from excitement or from participation in any functions which produce unusual excitement, worry, or anxiety. Especially should social functions of all kinds be abandoned during the nursing period, and if possible all cause for worry should be kept from her.

COMPOSITION OF HUMAN MILK COMPARED WITH THAT OF OTHER MAMMALS.

In the nutrition of the young of man the milks of only a few other mammals are employed, cow's milk being generally used in this country. In other countries, and sometimes in this, the milk of other mammals is used, namely, the goat, sheep, mare, and ass, but these are not common substitutes for mother's milk in the United States, and it may be said that the milk almost universally used in lieu of mother's milk is that of the cow.

Variations in the Composition of Different Milks.—Cow's milk is by no means of uniform composition. It varies in a very large degree, not only among different breeds, but among the individual animals of the same breed. The same statement may be made of mother's milk and the milk of other animals. The natural adaptability of the young child to slight variations in its nourishment is thus the necessity of its existence. This renders it advisable for a child deprived of its mother's milk to be nourished in a rational and systematic way in order to insure a growth which even approximates that provided by its natural milk-supply; in fact, if the mother be suffering in any way from a disease or from malnutrition, a better food for the child may be usually supplied from the cow than it would otherwise receive. Upon the whole, therefore, it may be said that the nutrition of the young infant deprived of its mother's milk is not so hopeless nor so difficult a task as is commonly supposed. It requires, however, a degree of skill, patience, and efficiency which is usually not found among those who are called upon to supply the needed nourishment.

Comparative Analyses.—If the student begins to look through authorities for the composition of mother's milk, he becomes at once confused. The best that can be done, therefore, is to say that the variations in mother's milk are quite wide, but not of a character to threaten the health of the infant. The principal ingredients of mother's milk are the nitrogenous constituents or protein, sugar, fat, and mineral substances. I have compared the analyses given by many authors, and it appears that the following may be considered a fair average of the data which have been reported, both for woman's milk and principal substitutes therefor:

	Woman's Milk.	Cow's Milk.	Goat's Milk.	Mare's Milk.	Ass's Milk.
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Protein,.............	1.5	3.0	2.80	1.90	1.60
Fat,................	3.5	3.9	3.40	1.00	0.93
Sugar,..............	6.5	5.0	3.80	6.33	5.60
Mineral matter (ash),	0.2	0.7	0.95	0.45	0.36
Water,..............	88.3	87.4	89.05	90.32	91.51

From this comparison it appears that human milk does not correspond to any of the principal milks which are used as substitutes. The amount of protein in the milk of the mare and the ass approximates more nearly the composition of human milk than does that of the cow's or goat's milk.

Value of Goat's Milk, Especially as to Fat Constituents.—Attention has already been directed to the composition of goat's milk and its possible utilization as an infant food. Some interesting investigations were reported by Dr. Bell in a paper read before the Section on Pediatrics, New York Academy of Medicine, in January, 1906. Goat's milk was fed to a number of infants under the care of Dr. Bell, and in many cases with good results. The average percentage of fat in the goat's milk used was 4.8 percent, and of proteids, 3.8 percent. In closing his paper Dr. Bell states:

In view of these physical and clinical differences in the various milk fats, not only as regards different animals but individual breeds, or possibly members of the same breed, and the experiments on animals with fat-laden foods relative to the digestive secretions, it seems reasonable and promising to make extensive clinical observations, so that we may be governed by practical as well as theoretical knowledge in this most important branch of our daily work. It seems probable that a great deal of mystery heretofore existing in the adaptation of milk to infant feeding, not only as regards fat, but proteid indigestion, will be largely cleared up by a more intimate knowledge of the chemistry of the fat constituents employed. In this connection we might pertinently ask if we are using the best and most economical source of milk supply. While not possible of confirmation, I believe good milch goats (the Nubian, for instance) will give a larger milk ratio per expense of food and keeping than the cow. She is more docile, less excitable, not subject to tuberculosis or other disease in this climate. Being a browser rather than a grazer, she will thrive when cows would not; and, above all, she is cleanly. Her excrement is solid and her tail short, consequently she is not covered with manure as is the cow. It is safe to assert that the production of cow's milk free from manure bacteria is commercially impossible. Not so with the goat; she can be easily washed (tubbed if necessary) and aproned for milking. I believe an assured non-contaminated goat's milk supply not only commercially possible but profitable.

Conclusions.—First, the digestion of fat retards the flow and diminishes the amount of gastric juice, at the same time lowering its digestive power. Second, the ingestion of fluid oil increases the flow of pancreatic juice and probably the activity of its fat-splitting enzyme steapsin. Third, in case the fat is not fluid at body temperature, it may still further retard and prevent the flow of gastric juice according to the first hypothesis mentioned by Dr. Labassoff, viz., coating over the gastric mucous membrane, thereby mechanically interfering with secretion, or in the case of coagulable food, such as caseinogen, by covering the curds with a layer of insoluble fat, thereby preventing the action of gastric juice upon them, though secreted in sufficient amount and power, and also by preventing the action of the trypsin upon them, though brought in contact with an increased supply of pancreatic juice, assuming that the action of the steapsin on the fats will be partially nil, or at least much impeded by the insolubility of their fat-covering permitting the curds to pass undigested. Fourth, if goat's milk fat, relative to that of cow's milk more closely approximates human milk fat, and if the proteid and sugar constituents are not more incompatible than in cow's milk, and if there exist no serious commercial obstacles, goat's milk merits an extensive and thorough clinical trial in infant feeding.

Composition of the Mineral Matter of Milk.—The average quantity of mineral matter in milk is pretty close to seven-tenths of one percent. The average quantity of mineral matter in woman's milk is considerably less and is variously given by different authors. There is also a marked difference in the composition of the mineral matters of the milks of flesh-eating animals and of herb-eating animals. Among the important mineral constituents of milk, or rather those of great dietetic importance, is lecithin, a substance allied to protein and which uniformly contains phosphorus. It is true that a considerable amount of the phosphorus which nourishes the tissues, and especially the bones of the growing infant, is provided from the phosphorus in the lecithin of its foods. Woman's milk is particularly rich in lecithin, and thus well suited to nourish especially those tissues of the body in which phosphorus is an important element, such as the bones, the nerves, and the brain. The milk of the goat contains slightly more mineral matter than that of the cow, while the sheep contains slightly less. The amount of mineral matter in the milk of the horse and the ass is not quite half as much as it is in the cow's milk. The percentage composition of the mineral matter does not differ greatly in different milks. The distribution of the mineral substances in the milk of the cow may, therefore, be regarded as typical of all. The average composition of the ash of cow's milk is as follows:

	Percent.
Lime,	20.3
Magnesia	2.0
Potash,	28.7
Soda,	6.7
Phosphoric anhydrid,	29.3
Chlorin,	11.0
Carbonic acid,	1.0
Oxid of iron	4.0
	103.0
Less oxygen as chlorin,	3.0
	100.0

The phosphoric acid, lime, and iron are the chief nourishing constituents of the ash of milk. The magnesia, the potash, the soda, the chlorin, and the carbonic acid are of less importance in nutrition.

Adaptation of the Milk of Each Animal to its Own Young.—Even a brief study of the composition of the milk of different animals cannot fail to lead to the conclusion that nature has provided for each kind of animal a particular kind of diet. We cannot even say that the same substances in different kinds of milk have the same nutritive properties, and certainly they have not the same adaptability. For instance, that constituent largely present in milk, namely, nitrogen or casein and its cogeners, while theoretically almost the same in any of the milks of the various animals, is in fact entirely different in its adaptability for nourishing the young. The same is true of the milk sugar, the fat, and the mineral constituents. Why this is so is perhaps beyond the power of man to say; that it is so, is evident from the fact that each kind of young does best on its own mother's milk. Investigations of the young of many animals have shown that these elements are present in the body of the young at the time of birth in almost the same proportion as in the natural milk of the mother of the animal. It has been found, for instance, that the milk of the dog had an ash content exactly the same as the body of a new-born puppy. Lusk draws the conclusion from this that the ash of the milk is perfectly adapted for the construction of the puppy tissue, and, further, he calls attention to the fact, that it is entirely different in composition from human or cow's or other milks.

Percentage Composition of Milk in Relation to Growth.—In addition to the preceding statements, it may be shown that the percentage quantity of certain milk constituents is related more or less closely to the rate of growth of the animal. Lusk quotes a table from Bunge which shows this comparison.

Kind of Animal.	Time in Days for the New-Born Animal to Double Its Weight.	100 Parts of Milk Contain:		
		Proteid.	Ash.	Calcium Oxid.
Man	180	1.6	0.2	0.0328
Horse	60	2.0	.4	.124
Calf	47	3.5	.7	.160
Kid	19	4.3	.8	.210
Pig	18	5.6	..	..
Lamb	10	6.5	.9	.272
Dog	8	7.1	1.3	.453
Cat	7	9.5	..	..

Lusk has made a careful study of the science of nutrition of young animals and has quoted many authorities supporting the conclusions which he has drawn. It is found, for instance, that human milk which is secured from three to twelve days after the birth of the child contains double as much iron at that time as is found at later periods of lactation. Especially if the mother is imperfectly fed, or lives in squalor or poverty, the percentage of iron in the milk rapidly diminishes. The quantity of lime in cow's milk is much greater than that required for the human infant, but is adapted to the needs of the calf. The relative composition of cow's and mother's milk at a period of lactation of five or six months shows a very distinct difference. For instance, the proteid in the cow's milk at that period is approximately 3.5 percent and in human milk only 1 percent, while the fat in the two are almost the same, though the cow's milk has slightly the greater quantity. On the other hand, the milk sugar in the cow's milk at five months is very much less than that in human milk at the same period of lactation. All these data show that there is not so much carbohydrate, that is, milk sugar, in cow's milk as is required for the normal nutrition of the human infant.

SOME PROFESSIONAL OPINIONS OF PREPARED INFANTS' FOODS.

Multiplicity of Infants' Foods.—In general it may be said that the multiplication of so-called prepared, artificial, or manufactured infants' foods cannot be looked upon with much favor. Such foods may often be kept for months before they are used; may be subjected to all kinds of bacterial and other contamination; and may fail in almost every respect to meet the conditions of ill health in infants, though at times they may, and apparently do, furnish the proper nutrition for a healthy child. These preparations, however, as will be seen in the more particular discussion which will follow, are not of the kind which require previous manufacture, but can be easily supplied at home by the intelligent mother or nurse. The evident advantage of the home-modified or prepared milk is that it can be made of fresh materials, and under the supervision of the one most interested in the welfare of the child. A collection of the analyses of some of the more commonly advertised infants' and invalids' foods is presented in the table given on page 590, under invalids' foods, more as an illustration of what has been done than with any idea of making a complete list of the foods offered for consumption, as their number is legion.

Definition and Standard for Infants' Foods.—Few countries have made an effort to establish an official definition and standard for infants' foods, but the colony of Victoria is an exception to this rule. In "The British Food Journal" for April, 1909, page 59, is found a definition and standard for infants' foods in the colony, which is as follows:

Definition: Infants' food is food described or sold as an article of food specially suitable for infants of twelve (12) months of age or under.

Standard: Infants' food shall contain no woody fibre, no preservative substance, and no mineral substance insoluble in acid; and, unless described or sold specifically as food suitable only for infants over the age of six (6) months, shall, when prepared as directed by any accompanying label, contain no starch, and shall contain the essential constituents of, and conform approximately in proportional composition to, normal mother's milk.

Prepared Infants' Foods Not Generally Commended.—Prepared infants' foods are not looked upon with general favor by the medical profession, especially those who treat principally the diseases of children. A common fault, which cannot be too strongly condemned, is the extravagant claims put forth respecting the merits of these prepared foods. Products showing wide typical differences in composition are advertised under practically the same claims for excellence. Against these extravagant advertisements must be placed the almost unanimous opinion of competent medical authorities, not interested in any way directly or indirectly in the preparation or sale of any particular kind of proprietary food.

It is not the purpose of this manual to deny that many of these foods are both nutritious and helpful in many cases; but it is certainly not to be supposed that they have all the virtues claimed for them. The discussion which follows must not be considered in any sense as an attack upon the value of prepared infants' foods; but only as an attempt to set forth as fairly as possible their actual composition and nutritive value; describe the methods of their preparation and administration, in so far as known, and to call attention to the fact that these foods are to be regarded as substitutes to be used only in cases of emergency and are not to be relied upon for the nourishment of infants in general.

One eminent practitioner says that he does not believe that any prepared infants' food can meet the requirements of infant feeding, because it is an individual and not a general question. Another says that a long experience in the feeding of infants has convinced him that an ideal food need contain nothing beyond the normal constituents of cow's milk, and that he has not found any necessity for the addition of starch or other modifying or converting agents. Another says: "In my opinion the constituents of the infant's food should be those of milk more or less modified in preparation to meet the individual case. In substituting cow's milk for mother's milk it is generally not necessary to split the proteins. On the contrary, it is generally better not to do so. It is quite as necessary to avoid an excess of fat as of proteins. Sterilization long continued in this case is capable of causing scurvy. Pasteurization with ordinary plants and ordinary care is not reliable, because of the danger of sterilizing on the one hand, or keeping at a fermenting temperature on the other. As a rule, neither is necessary with a clean milk and sufficient care."

Another writes: "I am opposed to the use of all infant foods except as they are makeshifts. As such they often serve the useful purpose of tiding the infants over periods where fresh milk is not tolerated. Their continuous and prolonged use is regarded as dangerous."

Dr. Brennemann, of Chicago, has contributed a chapter to Hall's work on "Nutrition and Dietetics," * in which the following statement is made:

The only food that meets all of the infant's requirements is human milk. This is especially true during the first few weeks of life, when any artificial feeding is often a dangerous substitute. Breast feeding should be encouraged in every way, even if only for a short time. The pessimism about increasing inability of mothers to nurse their babies is not entirely well founded. From the "consultations de nourrissons" in Paris, and from many other sources, comes increasing evidence that many more mothers would be able to nurse for many months, and nearly all of them for many weeks, if they were properly encouraged, and properly taught how to nurse, and how to care for themselves and for their babies.

Dr. Brennemann makes the following statements in regard to substitutes for mother's milk:

The very extensive use of these so-called "foods" warrants their brief discussion. For our purpose they may be divided into two classes:

1. Those that are advertised as complete foods in themselves and contain milk.

2. Those that are to be used only in conjunction with fresh milk, and are so advertised.

In the first class are the sweetened condensed milks, the malted milks, Nestlé's food, etc. Condensed milk is milk evaporated to about one-fourth of its volume with the addition of about forty percent of cane sugar. In the others the milk is evaporated to dryness, and sugar and partially or completely dextrinized flours are added. In the malted milks the predominant carbo-

* Reprinted from Hall's "Nutrition and Dietetics." Copyright, 1910, by D. Apple-

hydrate is malt sugar; they are all deficient in fat and fresh animal proteids, and contain an excess of carbohydrates. Many infants apparently thrive on them alone for some time, but are always less immune and resistant to infections, and practically invariably, if fed on these alone for a long time, will show decided evidence of rickets, often of scurvy, and other nutritional disturbances.

In the second class belong such malted foods as Mellin's and Horlick's, that are composed chiefly of dextrins and maltose, especially the latter; the farinaceous foods, such as imperial granum, Ridge's food, Robinson's patent barley flour, etc., that are composed largely, about 75 percent (Holt), of unchanged starch; Eskay's albuminized food, made up largely of dextrins, dextrose, and lactose, 67.81 percent (Holt); and starch, 21.21 percent (Holt). They take the place of the simpler carbohydrates, barley, oatmeal, sugar, etc., over which they have few or no advantages. The malt preparations are useful when malt sugar is desired rather than milk sugar or cane sugar. The farinaceous preparations form a convenient transition either in the milk, or as a porridge, to the cereals. The chief objections to these "foods" are the price; the use of the word "food," that leads the uninformed to think of it as the important part of the mixture and not the milk; the questionable claim that they have some special virtues as milk modifiers; and the directions which go with them that assume that all babies of a certain age are alike, and that the mother (for they are advertised to the laity) and a printed page alone can meet one of the most complex problems in medicine.

Opinions of an Eminent English Physician.—It is well to consider the opinions of those who have made a scientific study of the nutrition of infants and are qualified by their education and experience to judge of the efficacy of different foods. Dr. Robert Hutchison, who is the assistant physician to the London Hospital and the Hospital for Sick Children, has written most interestingly in regard to the large group of infant's foods offered to the consumers in England. He divides the English infants' foods into the following three groups:

1. *Complete Substitutes for Human Milk.*—In the first of these are included all which are intended to be complete substitutes for human milk and on which an infant may be healthfully reared without other food. He states that such foods are, practically speaking, desiccated milks, although many of them not only have had water removed, but have had other constituents added. Such foods may prove very healthful in the nutrition of children, but still must be used with caution. One important precaution is that when a child is more than a few months old some fresh fruit juices should be added to the food; otherwise scurvy may result. Such foods also have the disadvantage of containing too little fat. For the poor, however, the great drawback is the cost, as it is vastly more expensive to rear a child on one of these foods than upon fresh or even condensed milk.

2. *Malted Foods.*—The second class of infant's foods to which Dr. Hutchison alludes are those which contain malt, or which have been subjected to the

malting process. These, of course, are starchy foods in which the starch has been partly converted into sugar by the action of a diastatic ferment. According to Dr. Hutchison, infants under six months of age are not able to digest starch, and these predigested starch foods have been introduced to meet that difficulty. They are supposed to contain either no starch, or a starch which has undergone conversion into dextrin and maltose or dextrose in course of preparation. One of the foods to which reference is made is well known in this country and may be regarded, for practical purposes, as simply a desiccated malt extract. It bears to malt extract very much the same relation that some of the foods of the first group do to condensed milk. Dr. Hutchison suggests that an infants' food of this class, if a manufactured food is to be used, is about as good as any, but it is only intended to be used as an addition to milk.

This class of infants' food also includes those prepared with enzyms which are supposed to convert the starch during the preparation of the food. The chief objection to this (supposing such a conversion could really take place) is the haphazard method of preparing food in a general way in the nursery. The particular food, to which reference is made, is poor in fat, especially for a very young infant, and the child's diet is, therefore, apt to be deficient in that ingredient if such a food is largely relied upon.

3. *Starchy Foods.*—There is still another group of infants' foods, according to Dr. Hutchison, which make no pretense of being malted at all. In other words, they are starchy foods pure and simple. In some cases they may have been baked so that the starch grains have been ruptured, but otherwise they are very much like flour. Such foods may not harm children who are able to digest starch, and although they may be of some use, by way of change, they have no real advantage over simple preparations such as baked flour, oat flour, or any other ordinary cereal preparations. For children less than six months of age such foods should be avoided altogether. Dr. Hutchison says:

"I think that it must have fallen to the experience of everyone here to have seen a great deal of harm done by a misuse of these foods. In the case of adults who are confined to a semifluid diet such preparations may occasionally be of service, but an intelligent manipulation of flour, oatmeal, and an infusion of malt will make recourse to them very rarely necessary."

The Addition of Cereals to Infants' Foods.—There is a very wide difference of opinion in the medical profession regarding the advisability of the use of cereals in infants' foods. It may be said that there are two schools which are more or less in agreement on some points and quite opposed in their opinion on others. Of the one school it may be said that the admixture of some form of cereal to infants' foods is admitted only when cow's milk is substituted for the milk of the mother. The argument is that cow's milk is not a normal food for infants, and, therefore, when it is given the admixture of other substances may be indicated. The theory on which cereal foods in a proper state of subdivision and cooking are mixed with milk rests on the fact that it is supposed to render the curd less coagulable. In other words, the admixture of a certain quantity of rice flour, or barley flour, or wheat flour, to the milk tends to keep the curd subdivided and thus avoids the danger of a hard mass coagulating in the stomach of the infant. The experience of many eminent physicians in this line gives considerable weight to this theory, and it is fully developed in some of the standard works on infant feeding. A distinction must be made, however, in the opinions of many physicians, between those who have never been interested in any way in any particular form of infants' food, and those who have given their opinions at the request of manufacturers of these articles of diet. In the one instance the opinion must be regarded as unbiased, and in the other as subject to a considerable degree of suspicion. One thing should be kept in mind, and that is that the saliva of the infant contains at most only a trace of the digestive ferment which is capable of converting starch into sugar. This would indicate that a starchy diet is not a normal one for young infants. The boiling of the cereal in water and using the water is quite a different proposition, as in such cases very little starch enters into the solution. The extract from the boiled cereal is composed of soluble carbohydrates and other bodies soluble in water, and thus in the case of starch, if any be absorbed at all, the first steps of digestion have taken place. The addition of barley water or other cereal water to milk is, therefore, hardly to be considered in this discussion, but only the addition of actual starch. The other school of physicians is strongly of the opinion that starch should not be an integral part of an infant's food.

Pritchard has compiled the most recent information, based chiefly upon the work of Emil Fischer, relating to the digestion of carbohydrates in the intestinal tract. As a result of these investigations the whole conception of the nutrition of infants by starch has been greatly modified. While it is true that even very young infants may apparently dispose of starch by digestion in the usual way, it is found that this is not the case. Starch given at this early period of life may be digested, but it is digested in the wrong way, in the wrong place, and by the wrong agencies. Instead of the starch being broken down by the proper amylopsin ferment in the duodenum, it is attacked by bacteria in the colon and converted into irritating acids, such as acetic, butyric, and valerianic, and into gases, such as hydrogen, methane, and carbon dioxid. These results should lead pediatrists to an ultra-conservatism in advising starchy additions to synthetic infants' food.

Substitutes for Infants' Foods.—It cannot be admitted that the prepared solid foods which are not modifications of milk have any right to the name of infants' foods. They are, undoubtedly, substitutes for infants' foods, and should be so considered and named. It is not intended to deny that these foods often have value. They are in some instances undoubtedly utilized by the infant with benefit, and especially in those cases where the actual food, viz., milk, cannot be obtained in the quantity or of the quality desired. In such cases a clean, well made substitute may often save the infant's life. The number of so-called infants' foods, or substitutes for infants' foods, on the market is legion. They are made of widely varying materials put together in very different ways. They are sometimes composed chiefly of starch, while others have as the most important constituent sugar of milk or other sugars. Still other preparations consist largely of malted cereals, the starch during the malting process having undergone transformation, chiefly into maltose.

Relative Nutritive Properties of Different Substitutes.—No very definite statement can be made as to the relative value of these substitutes. It may be safely asserted, however, that a preparation composed chiefly of starch is the least desirable of all. Probably the most desirable would be those which contain large quantities of milk sugar or maltose, together with the constituents of the malt which accompany the maltose, that is, the protein and the fat. It is easy to determine the exact composition of these preparations by analysis, and in point of fact in many instances their chemical constitution is plainly printed on the labels, so that the users of them know exactly the relative quantities of fat, protein, and sugar which they contain. For nutritive purposes, however, especially in the case of infants, it is not sufficient simply to know the quantity of the several ingredients which are present. It is necessary also to know the state in which they exist and their origin. This information is not always communicated to the purchasers and users of these compounds. Theoretically, a substitute for infants' food which would have approximately the composition of the milk of the mother, of course excluding the water, would be most desirable. It would not, apparently, be difficult to prepare a compound of such a composition that when one part of it was mixed with nine parts of water the solution would have approximately the same relative composition as mother's milk, that is, 1 percent of protein, 2 percent of fat, 6 percent of milk sugar, and 1 percent of miscellaneous constituents. Even this composition would not be a guarantee that the product would be suitable for the nourishment of children. It would be quite impossible, in any artificial way, to make a mixture which would be identical in nutritive value with that secreted by the human breast. It cannot, therefore, be regarded as of prime necessity that substitutes for infants' foods should have approximately the composition of mother's milk. Departures of considerable magnitude might be made from this ideal standard without materially affecting the suitability of the preparation for nutritive purposes. The chief objection to these prepared foods is not that they vary widely from the dry substances in the mother's milk; the most serious objection lies in the fact that they are artificially compounded and cannot possibly take the place of nature's nourishment. It would be unwise to place them under universal ban, for reasons already given, but they should be used only in cases of necessity, or when the physician specifically advises their use and takes the full responsibility therefor.

Objections to Predigested Milk.—Predigested infant foods, and among them predigested milk, are often advertised. The converting of the protein of milk (casein) into a soluble form is one of the steps of digestion and the formation of curd in an infant's stomach is one of the most common causes of irritation, and also of nausea, colic, and diarrhea. It is highly desirable that this condition should be avoided, and attempts have been made to convert the casein of the milk into a peptone, or some soluble form of protein, before feeding. This process is called peptonizing the milk, and affects the casein as a diastatic ferment does starch. In other words, a diastatic ferment converts starch into a soluble form, sugar, and a peptonizing ferment converts the casein into a soluble form and thus makes it more readily digestible. It must be borne in mind, however, that the predigestion of any food is not a natural process. The functions of the body are strong and vigorous in proportion as they are legitimately exercised, and the feeding of a predigested food for any length of time cannot fail to impair the digestive organs. For this reason a predigested food should not be used except in cases of disease where it is necessary to tide over an abnormal condition in order that strength and health may be regained. In other words, it would be a mistake to feed a healthy infant any food modified in such a way as to prevent its digestive organs from performing their normal physiological function. Pritchard opposes the indiscriminate use of predigested or peptonized milk on these grounds, admitting, however, that it has some value in acute gastro-intestinal derangements or for short periods of time.

Commercial Literature and Opinions.—When it is considered that so much of the literature on infant feeding has been written for commercial purposes, and when it is further understood that the highest skill of the advertiser is employed both in wording the praises of infants' foods and in securing proper pictorial illustrations of their results, it is plain that the public may be misled in many instances. The only safe course in such matters is to have recourse to the medical profession, and to that part of it which is distinctly removed from any commercial interests in the subject. A physician may be very learned, very skilful, and highly appreciated by the people of the community in which he resides, and yet be biased if he is financially interested in an infant food or connected in any way with trade therein. Happily there are many hundreds of expert physicians who understand the subject of nutrition and who give their time to its study who have no interest of any kind, of a financial nature, in any infants' or invalids' foods. Their opinions for this reason are the more valuable. All statements concerning the science of infant feeding or the art of preparing infants' foods should be studied with a view to showing their origin and motive in order that the reader may give to each of the methods described a proper consideration and confidence.

Fundamental Principles Governing Infant Nutrition.—Dr. Chapin has made some pertinent observations on this subject. In the "Journal of the American Medical Association" for September 18, 1909, page 907, he says:

In reference to the infant's nutrition, we have always to deal with milk in some form, as biology shows that this is always the primary and elemental food mixture, containing in easily assimilable form all the food principles. While the different manipulations required to make various milks, or other forms of food, acceptable to the infant's stomach constitute the art of infant feeding, before any of these details can be accepted as scientific and thus of permanent utility, it must be decided how far they are in accordance with biologic laws. Biology must thus finally decide both the possibilities and limitations of every method that is advanced. This will call for a knowledge of the structure and functions of the various digestive tracts in connection with the peculiar characteristics of the milk early furnished to each species. This study will show not only how far different milks are interchangeable, but also throw light on the various manipulations that aim to make them so.

A chemical analysis of milk will show the ingredients of this fluid, and, to a certain extent, their potential food values from their quantitative amount. There is something beyond this, however, that chemistry cannot explain. While the fats and carbohydrates in their composition and reaction to the digestive secretions are a good deal alike in different milks, the proteins are essentially different. Chemistry alone can not explain this phenomenon. We must study the reaction of the protein to the digestive secretions, and then examine such reactions in relation to the growth and development of the digestive tract—in other words, investigate the question biologically before we can understand the problem.

A certain portion of the protein of all milks coagulates on coming in contact with rennin or rennin and acid, but the manner and extent of this coagulation stands in a direct relation to the proper evolution of the digestive tract of the animal.

The scientific principles involved in infant feeding are few and simple. The methods of applying them are many and may be as simple or as complex as one desires to make them. The point ever to be kept in mind is: What is the effect of a proposed method and does it apply correct scientific principles? Many of the methods that have been proposed are unscientific when employed as routine measures, although they may be scientific under certain conditions; and methods that may be scientific as routine measures may be unscientific when applied to abnormal conditions.

Various methods of preparing food have been well worked out and simplified, but they will be of little value to the physician unless he knows why, and how, and when to use them. In this way only can scientific methods prevail. Infant feeding can only become scientific by being placed in line with the methods of science in general.

MODIFIED MILK.

General Considerations.—The first important point in this connection is that the milk should be from a healthy cow which is kept in a sanitary condition, and that it should be drawn and handled in a thoroughly sanitary way. The proper methods of preparing milk are now well established as a practical result of modern sanitary theories. Inasmuch as the cow's milk is not chemically identical with mother's milk it is often advisable, especially in the case of infants in bad health, to modify the cow's milk so as to bring it more nearly in harmony with the composition of mother's milk. Although the same elements appear in the milk of practically all mammals, they are not distributed in the same proportions, nor do they have exactly the same dietetic and same physiological value. It does not follow that even if cow's milk is so modified as to chemically consist of the same general food elements present in the same proportions as in mother's milk, that such modified milk will have the same nutritive and physiological effects. In fact, experience shows that it is not possible for man to prepare a food which has exactly the same properties as that which nature provides. But, at least, one may use sanitary methods, as well as scientific principles, in the modification of milk.

It is well known that cow's milk contains more protein and less milk sugar than the normal milk of woman; hence the most natural modification is to bring the cow's milk into nearer relationship to the natural milk which the infant demands. When this is done under scientific principles, and according to the directions furnished by competent physicians, or physiologists, there is no objection to the modification if it is accomplished without the exposure of the milk to bacterial and other contamination. The addition of other products of any kind to milk in its preparation for infants' use cannot be generally recommended. There are times, however, when the use of an extraneous body may prove beneficial, but a competent physician should decide when such chemical modification is desirable.

Reasons for Modifying Milk.—By the term milk alone is meant cow's milk unless some other is specified. The reasons for modifying any other milk to resemble mother's milk are found in general in the following principles:

The percentage of protein should be diminished in cow's milk because an infant only needs milk with a low percentage, such as it gets in the milk of its mother. While a higher percentage of nitrogen may not do any injury if the digestive functions of the infant are particularly good, the ingestion of excessive quantities of nitrogen usually produces disturbances, and the whole organism as well as the stomach may be injured. This injury is first made known by loss of appetite, followed by colic, sleeplessness, irritability, and other symptoms.

It is important also that the milk have plenty of substances rich in phosphorus, such as nuclein and lecithin. Mother's milk is usually richer in these substances than cow's milk, and in the dilution of cow's milk there is naturally a dilution of those substances rich in available phosphorus. It is hardly advisable to add artificially prepared nuclein and lecithin, because they are less digestible than the natural constituents. In fact, it has been found by experience that if it is not possible to modify the cow's milk, it may be diluted with water free from any harmful germs. It is a remarkable fact that while a child may not thrive on whole cow's milk, it may thrive quite well on whole cow's milk diluted, without any other modification. Hence, in cases of irritability of the stomach of the infant which is fed other milk, it is advisable in practically every case to dilute it with water if it cannot be modified in any other way. The ingestion of more of any kind of food than the child requires places upon its organism, which is far from being able to bear any increased burdens at this period of life, the duty of digesting, oxidizing, and excreting excessive quantities of materials. Therefore children should not be heavily fed to make them fat. Although plumpness is regarded by most people as an indication of health, it may be, on the contrary, a premonition of disease.

The Addition of Milk Sugar.—The simplest modification of milk, aside from its dilution with water, consists in the addition of milk sugar, and in diluting cow's milk it is advisable always to add milk sugar if no other change is made. In this way a closer approximation will be made to the mother's milk than can possibly be secured by the use of water alone. A great many infants are successfully fed with mixtures of this kind and have a normal growth. In all cases the milk, the sugar, and the water which are used must be as free from bacteria as possible. In other words, the milk must be fresh, the milk sugar perfectly sterile, and the water practically sterile.

Experience has shown that artificially fed children do not digest their meals as rapidly as those fed mother's milk. If, for instance, it requires two hours to empty the stomach of a child fed mother's milk, it usually requires three hours if artificial feeding is practiced.

The Addition of Alkalies to Milk.—It is a common practice to give alkali in some form to the child, especially if it is living on other than its mother's milk. Limewater is the form of alkali most commonly prescribed. Cow's milk, if kept for any length of time, causes an acid reaction, and presumably the addition of the alkali is for the purpose of correcting this acidity. In the case of the healthy child, where the digestion is not disordered, it is doubtful whether the addition of the extra amount of alkali is warranted. It may be presumed that nature knows best the character of the food the infant should have, and while it is true that the mother's milk is slightly more alkaline, as a rule, than that of the cow, this does not warrant tampering with so vital a substance as an infant's food with chemicals of the character described. Doubtless, however, there are conditions of disordered digestion and disease in which the administration of an alkali in the form of limewater or citrate of lime may be recommended.

Modification by the Addition of Substitutes not Milk.—This method of modification, it seems to me, is one which should be regarded with suspicion.

There are many preparations sold on the market which are not intended to be used alone as infants' foods, but to be employed in modifying milk. They consist of various elements, and are usually either preparations of milk sugar, which may be sold under some fancy name, or preparations of malt or other cereals in which starch has been subjected to diastatic action and has been partially converted into maltose and intermediate products. There is always a question as to the desirability of using bodies of this kind. It is true that milk sugar is one of the most common additions to milk in the way of modification, and maltose is a sugar made by natural means and is probably as digestible as any other sugar not natural to milk. For instance, I do not think there would be anything to choose in healthfulness between adding maltose or adding cane sugar to the milk, for the purpose of modifying it to meet some particular need of the infant.

Attention should also be called in such cases to the possible bacterial infection of these foreign modifiers. While it is true that these foods are prepared usually with the aid of heat, they are not always perfectly protected subsequently against bacterial infection. Such infection is naturally not so much to be feared as that which comes from the use of milk of unknown composition and history. Above all, warning should be given against methods of modifying cow's milk at home which are given in the interest of any particular product. Such advice, even if good in itself, is not always applicable because it is not adapted to the particular case in question. For instance, a modification of milk which was excellent for one condition of child growth or for a certain child, might be entirely unfitted for use under other conditions of growth or with another child. The particular object, of course, of such directions for modification is the sale of the modifier, and as there are no better modifiers than milk sugar and barley malt, these can be kept at home at much less expense than by purchasing them under a fancy name. Many of these directions for the home modification of milk advise the use of either milk sugar or a malt product, and in that respect the advice is sound, as a rule, but that any particular modification can suit any particular case is a matter which must be determined by the observation of the child under feeding, either by wise parents or by a competent physician. I use the word competent, not with the intention of throwing any doubt upon the general competency of the profession, but especially with reference to the physician who has made a specialty of the science of nutrition, a branch of learning which, unfortunately, is not so extensively taught in medical schools as it should be.

Difficulties of Home Modification of Milk.—Whenever possible the milk should be modified at home. There are many difficulties, however, connected with this problem which must be considered. In the first place, the great majority of parents must purchase the milk, so that they do not know its character and know less of its composition. In case the milk is produced at home, the task is an easier one. It would be possible in such a case to select a healthy cow and ascertain by a few analyses the composition of her milk. It may be assumed that a cow in a state of health, and with feed which is reasonably constant in character and quality, produces a milk of reasonably constant composition. Hence, if one modification could be successfully secured, similar treatment on other days would secure a similar result. This is the only case, unless a certified milk of known composition can be bought, in which it would be perfectly safe to attempt to modify the milk at home. For those who cannot secure these conditions there should be modifying establishments, under the control of disinterested persons, furnishing milk according to physician's prescriptions and having a certain percentage composition.

Commercial Formulas for Infants' Foods.—Medical and commercial literature are rich in formulas for infant feeding. It should be remembered, however, that no matter how honest and efficient physicians and manufacturers may be, their statements, if self-interest be involved, must be accepted with discretion. More than that, a general formula cannot meet each individual case. For healthy infants a general formula might do very well, if it is a good one, because all healthy babies can digest practically the same character of food; but if the food is intended for an infant that is ill, a formula that might be suitable in one kind of disease would prove entirely unfit in another. In such a case the only proper method is to have a formula constructed by the physician in charge of the patient. Even in this case the study of the science of nutrition is so neglected in our medical colleges that the physicians are not always trained to prepare such formulas. Pure, fresh cow's milk, if obtained from a young and healthy animal and properly modified, is to be preferred to any preparation made according to formulas or prescriptions given *in absentia*.

It is interesting to compare the formulas which are put up by different manufacturers. In one book it is stated that the formulas and analyses which are given show the great number of modifications of milk that may be made for infants of different ages and conditions with a certain advertised food. The food so advertised is said to contain no starch and no dried milk or other indigestible matter; to be entirely soluble, and, with fresh milk, to make the nearest approach to mother's milk yet produced. Without calling in question the excellence of this preparation or the honesty of the manufacturers, it is at least desirable not to accept too blindly all the statements made.

Chemical Composition not a Complete Index to the Value of Infants' Foods.—The analytical data alone in connection with infant's food do not give reliable indications of its worth; as, for instance, a simple statement of the percentage of fat, protein, carbohydrates, salts, and water which are present in the prepared food and in the mother's milk, does not give any adequate idea of the relative degree of digestibility. Presumably, the fat which is in an infant's artificial food, as well as the other ingredients, should correspond as nearly as possible in character to the fat of human milk. It is certain that the milk of other mammals corresponds more nearly in the character of its various ingredients to the milk of the human animal than would similar foods derived from other sources, the carbohydrate, one of the universal constitutents of the milk of all mammals, being milk sugar, is practically of the same constitution in all cases. The protein is also practically the same, although it varies greatly in the amount and in the relative quantities of the different kinds of protein which are found in the milk. The mineral matters are largely of the same kind though also differing in amount. Hence in the consideration of analytical data in the judgment of milk, it is not sufficient merely to know that the composition of the milk approximates that of the milk of the infant's mother; one must also know whether the various elements making up this milk in the proportions given are similar in constitution to those which exist in its natural food. For instance, the following analysis is given in one of the advertisements of an infant's food for infants under one month of age:

	Percent.
Fat,	0.93
Proteids,	1.03
Carbohydrates (no starch),	2 31
Salts,	0.24
Water,	95.49
Total,	100.00

This analysis corresponds very closely to the composition of many modified milks which infants under one month of age get. It is made partially of milk, with a considerable quantity of water added to it, and a few grams of a well-known infant's food. The analysis is given, not for the purpose of condemning this food, nor of expressing any opinion concerning it, but simply to show that the analysis is not the sole basis of judgment.

In the same pamphlet the following analysis is given of a food intended for infants over six months of age:

	Percent.
Fat,	4.01
Proteids,	3.23
Carbohydrates (no starch),	6.99
Salts,	0.74
Water,	85.03
Total,	100.00

This analysis may well pass for that of a good rich cow's milk, were it not that the carbohydrates are somewhat higher than would be normal. It is, however, a compound made from dilute cream, milk, water and a solid infant's food. The carbohydrates are composed largely of other substances than milk sugar. An infants' food of this kind might give most excellent results in some cases, and not in others.

A Practical Method of Distributing Clean and Scientifically Modified Milk.—There are many organizations in the United States having for their object the securing of pure milk for infants. There is no disposition to discriminate in regard to the efficiency of any of them, but it is of interest to give a method of procedure which is representative of work of this kind. The Babies' Hospital Milk Dispensary of Newark, New Jersey, may be used as an illustration. This dispensary has now been in operation nine years. During this time, little by little, the work has been perfected, the organization completed, and many improvements have been suggested and put into operation in connection with this charity. At the beginning of the tenth year the work of this dispensary is aided by a committee consisting of representatives of several philanthropic and charitable organizations in the city. This committee is known as the Joint Committee on the Summer Care of Babies, coöperating with the Babies' Hospital Milk Dispensary for a larger distribution of pasteurized milk to the infants of the poor, from milk stations conducted at several points, in order to place wholesome milk within the reach of all. During the nine years of service the milk dispensary has distributed 1,441,126 bottles of milk, and has fed over 3000 babies. The first year of its activity it sent out 66,000 bottles, and the ninth year 258,000 bottles.

Committee Formulas for Modifying Milk.—This committee has constructed six formulas for the modification of milk. In the case of sick babies these compounds may be diluted with either boiled water or sterilized cereal water, in order that the milk which has been pasteurized may not become reinfected.

Mixture No. 1. (From birth to two months, and for starting feeble cases.)

	Percent.
Milk fat,	1.00
Albuminoids,	1.00
Carbohydrates,	5.50

Eight bottles, of 4 oz. each, per day.

Mixture No. 2. (Two to four and one-half months.)

	Percent.
Milk fat,	2.00
Albuminoids,	1.00
Carbohydrates,	6.00

Seven bottles of 5 oz. each.

Mixture No. 3. (Four and one-half to six months.)

	Percent.
Milk fat,	3.00
Albuminoids,	1.50
Carbohydrates,	6.00

Six bottles of 6 oz. each.

Mixture No. 4. (Six to nine months and until weaning.)

	Percent.
Milk fat,	3.50
Albuminoids,	2.00
Carbohydrates,	6.50

Six bottles of 8 oz. each.

Mixture No. 5. (Nine to twelve months and during second year.)

	Percent.
Milk fat,	4.00
Albuminoids,	3.00
Carbohydrates,	4.50

Five bottles of 8 oz. each.

Mixture No. 6. (For temporary use with infants having fever or diarrhea.)

	Percent.
Milk fat,	0.25
Milk proteids,	1.00
Milk serum,	25.00
Cereal water,	50.00

Eight bottles of 4 oz. each (to be diluted for infants under six months).

Directions for Use.—The milk is adjusted to the requirements of normal infants during the year, the six mixtures as described being furnished, and diluted for sick babies by adding boiled water or boiled cereal water. It is not intended that a full bottle shall be given to a baby that is just beginning the age periods indicated in the formulary. A small charge is made for this milk so that it is not a complete charity. The milk furnished by the committee is not certified milk, but is good milk which is carefully pasteurized, and, therefore, has both the merits and demerits which attach to pasteurized milk.

Straus Laboratory Formulas.—The following formulas for modifying milk are recommended by the Straus Laboratories:

First to Fourth Week:

¾ ounce of 16 percent cream.
3 ounces of full milk.
19 ounces of water.
1½ ounces of limewater.
1½ ounces of milk sugar.
This mixture fills 8 bottles—each to contain 3 ounces. Feed two and one-half hours apart.

First to Third Month:

1½ ounces of 16 percent cream.
3 ounces of full milk.
13 ounces of water.
½ ounce of limewater.
1 ounce of milk sugar.
This mixture fills 6 bottles—each to contain 3 ounces. Feed three hours apart.

Second to Sixth Month:

18 ounces of full milk.
16½ ounces of water.
1½ ounces of limewater.
1½ ounces of milk sugar.
This mixture fills 6 bottles—each to contain 6 ounces. Feed three hours apart.

Third to Seventh Month:

18 ounces of full milk.
18 ounces of barley water.
1 ounce of cane sugar.
20 grains of table salt (less than ¼ teaspoonful).
This mixture fills 6 bottles—each to contain 6 ounces. Feed three hours apart.

Seventh to Ninth Month:

32 ounces of full milk.
16 ounces of barley water.
2 ounces of milk sugar.
This mixture fills 6 bottles—each to contain 8 ounces. Feed three hours apart.

After Ninth Month:

Full pasteurized milk, 8 ounces every four hours.

To make one quart of Oat or Barley Water.—Boil 2 tablespoonfuls of the flour in a quart of water until it is reduced to half the quantity; then add sufficient water to make up the quart.

Preparation of Milk for Infant Feeding at a London Hospital.—One of the best descriptions of the preparation of milk for infant feeding, especially for the nourishment of sick infants, is that found in the report prepared by Dr. Ralph Vincent, Senior Physician to the Infant's Hospital, Westminster, London. Dr. Vincent eliminates from possible infants' foods the artificial preparations which are so often recommended for that purpose, and also advises that even in the case of growing children a milk suitable for infants should constitute a large proportion of the daily food. Usually cow's milk is the only kind available, the supply of mare's, goat's, or asses' milk being so limited as to be practically excluded from commercial considerations.

Importance of Adequate Nourishment.—Attention is called in this connection to the especial necessity of insuring that growing children are well nourished in order that pathogenic organisms may be speedily overcome. It is a well-known fact that healthy children make a speedy and complete recovery from infectious diseases such as scarlet fever or measles, and often seem better after the attack than before, while in the case of poorly nourished children most serious and continuing results follow, such as deafness, rickets, and other ailments. Even special and general tuberculosis is not an unusual complication when the child's vitality is not sufficient to repel the invasion of the hostile pathogenic germs.

Quality of Original Milk.—The character of the milk employed in the Infant's Hospital is described by Dr. Vincent somewhat as follows. The milk is obtained from a farm which is entirely under the control of the authorities of the hospital. The milking shed is apart from any other stable and the cows are in it only during the milking. The attendants are required to sterilize their hands and clothing and to use sterilized vessels, while the cows are kept so clean that no possible filth of any kind can fall into the pail during the process of milking. The cows are specifically selected for their milk-giving qualities, Jerseys and Guernseys which produce excessive amounts of fat, being excluded from the herd. They are fed well-balanced rations of wholesome feed from which all slops, oil-cake, brewers' grains, and other questionable feeds are excluded. Grass, hay, pea-meal, bean-meal, and mangolds are some of the chief articles used for food, the greatest care being exercised to prevent an undue proportion of roots and green food, as these should be present only in sufficient quantities to make the rest of the food palatable and wholesome.

Care of Milk.—As has already been stated, the milking is conducted as nearly as possible on the principles of aseptic surgery. As soon as the milk is drawn it is separated into fat-free milk and cream by appropriate machinery. The two products are immediately cooled to 38° F. and placed in sterilized containers. These containers are constructed throughout with a double wall. Between the outer and inner walls is a layer of air, so that the temperature of the milk rises very slowly during transportation. The milk is received at the hospital within four hours after the milking and is there subjected to systematic bacteriological and microscopical tests.

A remarkable fact in connection with the production of this milk is that the records of expenditure shown by careful bookkeeping indicate that the total cost to the hospital is 25 percent less than the ordinary retail price of milk in London.

Composition of Milk.—Vincent gives the comparative composition of human milk and cow's milk as ascertained at the Westminster Hospital as follows:

	Human Milk. Percent.	Cows' Milk. Percent.
Fat,	4.00	4.00
Milk sugar,	7.00	4.50
Proteins,	1.50	3.50
Mineral salts,	0.25	0.75

It is seen that the mere dilution of cow's milk with water fails utterly to produce a milk which approaches in composition the average of human milk. It is evident that the relative composition of a diluted milk is exactly the same as it was before, that is, the ratio of the proteins to the milk sugar, the fat, and the mineral salts, or of any one of these four to the other three, is not changed. But in order to simulate mothers' milk the ratio must be changed in such a way that while the fat remains practically the same, there may be a marked change in the ratio of the other three constituents, namely, milk sugar, proteins, and mineral salts. Vincent distinguishes the proteins as whey-proteins and caseinogen, and gives the following proportions of the percentages of each in human and cows' milk:

	Human Milk. Percent.	Cows' Milk. Percent.
Whey-proteins,	1.00	1.00
Caseinogen,	0.50	2.50
Total,	1.50	3.50

It is seen that in a given quantity of human milk the whey-proteins will be very much in excess of the caseinogen, almost or quite double, while the reverse of this is true in cow's milk, where the proportionate quantity of caseinogen is more than twice that of the whey-proteins. The caseinogen is considered far less digestible than the whey-proteins, hence the additional necessity of some modification of the cows' milk to meet the demands of the infant.

Principle of Modification.—The principle of modification of the milk at the Westminster Hospital is a strict adherence to a standard human milk in its natural condition. Boiling, pasteurizing, or cooking the milk in any way is wholly forbidden. Sterilization is applied to the vessels in which the milk is contained, but not to the milk itself. In modifying the milk it is necessary to have certain standard solutions which are available for instant use. Standard solution No. 1 is standard cream diluted with fat-free milk so as to contain 32 percent of butter fat. The fat-free milk obtained by the separation previously mentioned is standard solution No. 2; standard solution No. 3 is saturated solution of calcium hydrate free of calcium chlorid; standard solution No. 4 is a milk-sugar solution containing 20 percent of lactose; standard solution No. 5 is whey prepared from precipitating the caseinogen from fat-free milk; standard solution No. 6 is sterile water obtained by filtering water through a Pasteur-Chamberland filter. Each of these standard solutions is placed in a sterilized metal tank partially surrounded with ice, and the milk is made by taking a specific quantity from each of the tanks to fill a given prescription.

Sample Prescription.—The prescriptions are of course varied according to the specific needs of each infant.

The following is a sample prescription, showing the amounts of each of the standard solutions prescribed in one case:

Ward 1, Infant No. 24

	Percent.
Fat,	2.00
Lactose,	6.50
Whey-proteins,	0.75
Caseinogen,	0.25
Alkalinity,*	5.00

Ten tubes each of 4 oz.

In the laboratory the prescription is translated into actual amounts. The following is the translation of the above prescription:

	Cubic Centimeters.
Cream (32 percent),	75
Lactose solution (20 percent),	121
Whey,	858
Fat-free milk,	59
Limewater,	60
Water,	27

* Expression "alkalinity 5 percent" indicates that 5 percent of the total volume of the mixture consists of standard solution No. 3.

Storage of Milk.—Attention is called to the importance of permitting as little change as possible to take place in the milk from the time of the milking until it is consumed by the infant. For this reason the storage of the milk and of the standard solutions made therefrom should be at a low temperature approaching that of the freezing-point of water. In this way the changes which would naturally take place due to growth of bacteria at room temperature are kept at a minimum. It is unnecessary to say that before the modified milk, after preparation, is given to the infant it should be restored to the normal temperature of the human body, or a little above, that is, to about 100° F.

PRESERVATION OF MILK.

Introduction.—It has been stated already that the ideal food for children deprived of nature's supply is a milk properly balanced in its nutritive elements to suit the organism of the child, and which is as fresh from the dairy where it was produced as possible. There are many cases, however, in which it becomes necessary to use milk which cannot possibly be fresh. For example, there are localities where fresh milk cannot be obtained, and long journeys by sea and land may render fresh milk inaccessible. Hence it is necessary to consider the art of preserving milk in order to meet such exigencies and emergencies. While no preserved product is to be preferred to the fresh milk, there are some methods which injure the character of the milk so little as to be preferred to others in which greater dangers from preservation must be expected.

Cold Storage.—Allusion has already been made to the keeping of milk by cold storage. This is by far the best method when the milk is to be kept only a few hours, or at most over a day. Fresh, sweet, clean milk may be cold stored at or near the freezing-point for twenty-four or even forty-eight hours and still be suitable for feeding to infants after it is warmed to the proper temperature. Fortunately, the very exigencies which require the preserving of milk are those which would preclude the possibilities of preserving it at least for a longer period than that mentioned. A mother traveling on a railway train might well pack the milk for her infant with ice and carry it with her, replacing the ice from time to time as it melted. In this way, through a journey of twenty-four hours, she could have the milk which she knows to be pure, at all times, removing a small portion of it now and then from its container and warming it to the proper temperature for feeding the child. A longer period than twenty-four hours for keeping milk by cold storage should not be advised.

Chemical Preservatives.—Many attempts have been made to keep milk fresh by means of chemical preservatives. By the term chemical preservatives is meant those substances which, without having in themselves any marked taste or odor, are capable of paralyzing or inhibiting bacterial action, or of actually killing the bacteria, and thus preventing the ordinary fermentative and putrefactive processes. Among the substances which are used for this purpose in milk, formaldehyde and boron compounds have been most common. Practically all nations have, by legislation or judicial decision, prohibited the use of these preservatives in milk, though some permit the presence of boron in other substances. In this country the presence of borax and formaldehyde is forbidden in milk, but benzoate of soda may be used in any quantity desired by the manufacturers, provided its presence and the amount employed be stated on the label. Fortunately, benzoate of soda is an extremely poor preservative for milk, since milk is an alkaline body, and as such it does not tend to decompose the benzoate of soda and set the benzoic acid free, and it is only free benzoic acid which is very active as a preserving agent. In so far as I know, very little use has been made by milk producers and dealers of the permission granted to use this chemical. In point of fact, there is very little adulteration of milk with chemical preservatives in the United States. National, State and municipal laws have been so well drawn and so vigorously executed as to practically put a stop to this objectionable practice. Whatever may be true of the ability of adults to tolerate a certain amount of chemicals in their food, it must be admitted that the infant is not thus constituted. No matter what the chemical may be, nor what the opinion or experience may be concerning its action upon health, there are few who have the temerity to urge either the unrestricted, or even the restricted, use of chemical preservatives in milk.

Condensed Milk.—Owing to the difficulty, in many cases, of securing fresh milk for the use of infants, condensed milk has been very widely recommended as a substitute. There are several difficulties which arise in connection with the use of condensed milk for children instead of the fresh milk which they naturally should have. In the first place, one should be certain that the condensed milk is made from fresh milk produced by healthy cows. It is entirely possible to conceive of a situation where milk is delivered to the condensory which is unfit for infants' food. Milk coming from unsanitary dairies, or from diseased cows, or which is handled in an unsanitary manner, or which is kept too long or at too high a temperature becomes unfit for consumption by infants, and, therefore, totally unfit for condensation if the condensed product is to be consumed by infants. If condensed milk is to be made part of an infant's diet, it should be produced from a certified fresh milk free from every possible disease germ, transported to the condensory in the most sanitary manner, and evaporated in the shortest possible time after reception. While it is idle to claim that such a condensed food is as good for the infant as the fresh article would have been, it must be admitted that such a product would be preferable to the indiscriminate fresh milk supplies of our towns and cities.

In fact, for congested centers where it is difficult to secure fresh milk at all, I think no one would doubt that a properly manufactured condensed milk would be a most helpful substitute. A milk prepared in this way and securely canned and sterilized will keep for a limited time, especially if held in a cold place, without developing any undesirable qualities. In this condition the milk could be much more easily transported and delivered to congested centers than could fresh milk. In my opinion, it would be a boon to the children of the poor in our large cities if an abundant supply of properly prepared condensed milk could be secured for them. I say this without in any way departing from the opinion, which I think is a correct one, that, if possible, perfectly fresh milk should always be secured. But such possibilities do not offer themselves to poorer residents of densely populated cities, and hence it seems to me that a properly certified condensed milk would prove a great blessing in such circumstances. Pritchard, however, maintains that fresh milk is the thing to be desired in all cases for healthy infants, and that the more milk is manipulated, the more it loses some subtle quality, the loss being due principally to the destruction of the proteolytic and fat-splitting ferments. He does not attach any value whatever to dried or condensed milk as a food for infants; if the fat in the milk has been reduced by water or otherwise, he advises the use of the emulsions of cod-liver oil, or of olive or other vegetable oils.

Composition of Condensed Milks.—The composition of condensed milk is determined by the character of the fresh milk. If the fresh contains a large percentage of fat, the condensed product will show a preponderance of that constituent. If, on the other hand, the fat is abnormally low, then the finished product will have the same deficiency, and the same is true of each of the constituents of the milk.

The following analyses of four different brands of evaporated or unsweetened condensed milk and two brands of sweetened condensed milk show the typical composition of such products:

EVAPORATED OR UNSWEETENED CONDENSED MILKS.

Constituents.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
Water,	72.03	70.26	72.17	71.34
Fat,	8.42	8.97	8.09	8.18
Proteins,	7.10	7.83	7.25	7.29
Ash,	1.68	1.44	1.67	1.59
Lactose by difference,	10.77	..	10.82	..
Lactose by copper reduction,	..	10.85	..	10.83
Undetermined,	..	0.65	..	0.77
	100.00	100.00	100.00	100.00
Total solids,	27.97	29.74	27.83	28.66
Fat in solids,	30.10	30.09	29.07	28.58
Ratio of proteins to fat,	1 : 1.18	1 : 1.15	1 : 1.12	1 : 1.12

SWEETENED CONDENSED MILKS.

	Percent.	Percent.
Water,	26.87	24.90
Fat,	9.82	10.30
Proteins,	8.04	8.77
Lactose by difference,	11.11	11.18*
Sucrose,	42.22	42.12
Ash,	1.92	1.85
Undetermined,	..	0.88
	100.00	100.00
Total solids,	73.13	75.10
Milk solids,	30.91	32.98
Fat in milk solids,	31.77	31.23
Ratio of proteins to fat,	1 : 1.22	1 : 1.17

It is a very common practice to add sugar to the milk at the time of its condensation, in order to preserve it more readily. Such products are known as sweetened condensed milks. The usual quantity of sugar used is about 40 pounds to 100 of the condensed product. The added cane sugar is usually in greater quantity than the natural milk sugar. I cannot see any advantage, in so far as infant feeding is concerned, in using a sweetened condensed milk rather than a plain product. While there is no positive evidence that sugar is hurtful, it at least is not natural. The infant fed at the breast would probably not consume any cane sugar at all, and the only sugar it would have would be the milk sugar of its mother's milk. To add a larger quantity of another sugar, while it would not harm adults, and possibly might not injure infants, would certainly modify the natural sustenance of the child to a marked degree. For this reason alone the sweetened condensed milks would not be desirable for infant nutrition.

Density of Condensed Milk.—An important factor in regard to the purchasing of condensed milk is found in the fact that it does not always have a uniform density. The national standard for condensed milk requires that it shall contain not less than 28 percent of solid matter, while many of the milks found upon the market contain decidedly less than this amount. To the poor man especially, who buys his condensed milk at a high price, it is of some importance to know whether he gets a sufficiently condensed article, or whether he is buying a large amount of water.

Difficulties of Making Condensed Milk.—Many manufacturers claim that it is difficult, and sometimes quite impossible, to produce a condensed milk with a content of 28 percent of solid matter. It is claimed that at such a degree of condensation a crystalline, sandy product separates after standing for some time, presumably composed largely of citrate of lime, which gives to the milk a bad appearance and prejudices the consumer against its use. Without calling into question the good faith of this statement, it may be said that many manufacturers do constantly make a condensed milk with 28 per-

* By copper reduction.

cent and over of solid matter, and do not have any special difficulty in preserving it for a proper length of time. It is true, doubtless, that most highly condensed milks would, in course of time, produce a crystalline deposit of the character named, but this would only show that the milk had probably been kept longer than is desirable. In the case of condensed milk, the fresher it is when used the better. As the supplies of condensed milk are made throughout the year, there should be no difficulty in getting a product for consumption which is less than three months old. Such samples of recent manufacture would doubtless in most cases fail to show a crystalline deposit in any appreciable quantity.

Drying Milk.—The drying of milk and reducing the product to a powder has become quite an industry in the United States. Many methods of desiccation have been tried, but the effective ones all depend upon two principles —first, rapidity of drying, and, second, drying at comparatively low temperatures. The object in drying the milk is to remove only the water, so that when the same amount of water is added, the milk will be restored practically to its normal state. To this end it is necessary that no part of the soluble materials of the milk become coagulated in drying; otherwise the addition of water would not restore the milk to its former homogeneous state. A certain portion of the protein of milk is composed of albumen, and, as is well known, albumen, when heated to a temperature which is very much above blood heat, becomes solidified or coagulated and is no longer soluble in a menstruum like the water of milk. Various forms of apparatus have been devised for drying milk at a low temperature. The most common method has been drying in a very thin film on metal plates, sometimes in vacuo, the vapor of the water being given off rapidly and at a very low temperature. The result is that milk can be reduced to a dry state in a short time and without reaching a temperature sufficiently high to coagulate the albumen. Such a product when mixed with water is practically restored to its original state.

Another method of drying milk consists in atomizing it under pressure and projecting it into a warm chamber the temperature of which is so regulated that the particles of vapor before they reach the bottom of the drying vessel are completely deprived of their water. The milk is thus reduced at once to a state of fine subdivision. When treated in this way the milk does not reach a temperature sufficiently high to coagulate its albumen, and, as in the other process, it is readily restored to practically its original condition.

Keeping Qualities of Milk Powder.—By reason of the amount of fat in the milk powder it is quite likely to become rancid if kept for a very long while at room temperatures or exposed to the air. A milk powder, therefore, however prepared, should be kept in a cool place and out of contact with the air as far as is possible, until used. It is very important that it be placed in packages which are practically air-tight, in order to prevent this rancidity, in case cold storage facilities are not at hand. In any case the dried milk powder should not be kept for any length of time, but should be consumed as soon as possible after it is made. Nevertheless it must be admitted that for purposes of transportation the milk powder has advantages over any other form of milk. Since practically 88 percent of milk is water, it is seen that in so far as transportation is concerned, there is great economy in carrying milk powder instead of the milk itself. Thus for long journeys on which milk in its natural state cannot be secured, and even for railway and steamship travel, dried milk may prove useful. In all cases, of course, it is assumed that the milk powder is obtained from milk which is derived from healthy cows, under sanitary conditions, and is free from any infection.

PASTEURIZATION AND STERILIZATION.

Process of Pasteurization.—The word "pasteurization" is derived from the name of the immortal scientist Pasteur, who found that it was not necessary to kill all the organisms in the milk to keep it fresh for a limited time, but that a gentle heat, far below the boiling point of the milk, would kill practically all the organisms which cause the milk to speedily sour and solidify. Bodies which are heated to a temperature below that necessary to kill all the germs and spores of the germ are said to be pasteurized. In point of fact the temperature of pasteurization which is usually employed varies from 130° to 160° F., which, as is seen, is very much below the boiling point which is always employed if complete sterilization is required. The point to be kept in view in pasteurizing is, that all parts of the milk shall be heated to the same temperature. Let us assume that this temperature is 150°. All of the milk then must certainly be heated at that temperature probably for about twenty minutes, and then rapidly cooled and kept free of infection from the air or other sources. Milk thus treated will remain sweet for two or three days, and perhaps in many instances, if kept cold, for a longer period. Pasteurization is recommended by a great majority of hygienists for all milk supplies the origin and nature of which are unknown. The objections to pasteurization will be mentioned later. It must be admitted, however, in the interest of public health, that as the milk supplies of the world are produced at present, especially those going to large cities, general pasteurization would be highly desirable.

Process of Sterilization.—As has already been intimated, sterilization differs from pasteurization in that the temperature of the milk is raised to the boiling point of water, or above. The object of sterilization is to remove completely all bacterial life from the milk; not only to kill the bacteria which are present, but also any spores which may subsequently develop into bacterial activity. Bacteria usually multiply by fission, that is, one bacterium develops a constriction which gradually increases until it is cut in two, making two individuals, and these in turn undergo the same process, and so on ad infinitum, until the development of the growth is stopped by lack of food, changes in temperature, or otherwise. Other bacteria are produced by spores, which have the same relation to the bacterium as the egg to the chicken. These spores are more resistant to heat than the bacteria themselves, and hence the heat must be higher or longer continued in order to completely destroy them. As has been indicated, sterilization is objectionable in the preservation of milk for two reasons, first, in that it gives it a bad taste, and, second, that it so modifies the structure of the milk as to decrease, to a certain extent, its digestibility, especially for infants.

Bacteriological Characteristics of Milk.—There is nothing more important in the subject of infant feeding than the bacteriology of milk, and it may properly be considered in connection with the pasteurization and sterilization data. Though all possible sanitary precautions may be observed, the number of bacteria in milk rapidly increases on standing. Under sanitary conditions this increase is a matter of no consequence, up to a certain limit, since the bacteria which are thus introduced are wholly harmless, and have even proved beneficial. When milk is secured from healthy cows in a sanitary manner and properly handled by chilling and bottling, the bacterial count may be usually kept below 10,000 per cubic centimeter. But it is only by the exercise of careful supervision that such a condition can be secured. The ordinary milk of commerce often contains millions of bacteria per cubic centimeter and sometimes over a hundred million. If these bacteria are wholly harmless, such a milk may not prove injurious to a grown-up person, but even harmless bacteria, in the ordinary sense of that word, in such numbers in milk given to infants, especially if they are very young, may prove extremely detrimental. The milk which is secured for infant food should, therefore, always be obtained in the most sanitary way, and if possible it should contain less than 10,000 bacteria per cubic centimeter.

Milk a Favorable Medium for Bacterial Growth.—There is perhaps no more favorable medium for the growth of ordinary bacteria than milk at certain temperatures, that is, from 70° to 90° F. Milk is not only an ideal food for an infant, but also for a bacterium. In point of fact the latter thrives even better than the former on a milk diet. The increase in the bacteria in milk in favorable circumstances is marvelous; the number in a few hours may grow from practically none to many millions, so rapidly do they multiply. The milk affords every food which the bacterium requires and in the form best suited to rapid assimilation. Inasmuch as the bacteria digest their food they must put into the milk large quantities of excremental matter, mostly in the form of enzyms, which may act as an irritant upon the delicate and sensitive coats of the intestinal tract of the infant. The rapidity of growth is very greatly checked by lowering the temperature; even if not brought under 50°, the growth of the bacterial flora is greatly limited. Milk may be kept at a temperature just above the freezing point for a long time, so greatly does low temperature interfere with the growth and reproduction of the bacteria. But even under these conditions, although the milk may not sour, bacterial life is by no means wholly destroyed, though its character may be profoundly modified. Changes of an objectionable nature, so far as infants are concerned, go on in milk stored at these low temperatures without giving any of the ordinary evidence of decomposition. For this reason it is not advisable to feed infants stored milks, that is, those which are stored in the fresh state, without pasteurizing or sterilizing.

Kinds of Organisms in Milk.—Yeasts as well as bacteria grow with great rapidity in milk, and the forms which produce acidity, that is, lactic acid, are likewise found growing with great vigor. Among the most objectionable forms of bacteria in milk are those which produce putrefaction, or, in other words, decomposition of the protein bodies of the milk. This putrefaction gives rise not only to bad tastes, but to bad odors. Putrefactive bacteria are found everywhere, but particularly do they collect around stables, where the soil is very rich and where there is much manure. Another bacterium which is particularly objectionable in milk is that which produces the sliminess so often found. There are also numbers of chromogenic bacteria in milk, which produce various shades of blue, red, and yellow. These, fortunately, are not very common. Again, the protein may be converted into peptone, which is the first step toward putrefaction. The conversion of the protein into peptone, if it stops there, is not harmful, but it is difficult often to draw the line between peptonizing and putrefaction. It would be useless to undertake to give any description of a popular character of the bacteria, since this is a subject which is extremely technical.

Bacterial Count of Milk.—It may be asked, and very properly, how can anybody count hundreds of thousands or millions of bacteria in a little particle of milk, not much more than a dozen drops, which would make a cubic centimeter? The answer is that it is impossible to do so. Bacteria are counted by adding some of the substance which is supposed to contain them to a sterile dish which contains nutritive material, usually of a gelatinous nature, suitable for the growth of bacteria. Each bacterium in the added substance grows on the surface of this nourishing medium and produces colonies which can be seen with the naked eye. The number of colonies found indicates the number of bacteria in the original milk. In order to secure a count, therefore, it is necessary to dilute the milk often many times before adding a drop of it to the sterilized medium. If milk is diluted a thousand times and a cubic centimeter of it is found to contain a hundred organisms, we only have to multiply the hundred by the thousand to get the total number originally present. The cilful bacteriologist by making a number of trials will be able to approximate, ith a very great degree of accuracy, the total number of bacterial organisms ı the substance with which he is working.

Result of Pasteurization.—Let us understand at the first that pasteuriation cannot purify milk. If milk is dirty before pasteurization, it is just as irty afterward, but the greater number of germs which it contains have been illed or paralyzed. Fortunately pathogenic germs which are the most obctionable ones in milk are quite susceptible to the influence of heat, and are uite likely to be destroyed by a proper pasteurization, while other germs which re not objectionable may continue to live and develop. The mother who eds her infant on pasteurized milk, assuming that it is properly done, may el assured that none of the contagious diseases which can be transmitted y milk, namely, typhoid fever, tuberculosis, diphtheria, etc., will be given to ie child; but at the same time she may be certain that the nutritive value of ie milk, if it was low before pasteurization, is even more so afterward since is proven by experience that infants, as a rule, do not thrive so well on paseurized milk as they do on good milk which has not been pasteurized. One reat advantage of pasteurization is that the milk thus treated does not have ie burnt taste which is so objectionable to many people in milks which have een subjected to the boiling temperature. Others who are accustomed to ie taste of boiled milk, however, do not object to it, and in such cases, if is a grown person, it is far better that the milk should be absolutely sterilzed. For infant's use, however, I am of the opinion that boiled milk is not o wholesome nor so nutritious as pasteurized milk, just as pasteurized milk not so wholesome nor nutritious as perfectly fresh and pure milk. The value f pasteurization, however, as a prophylactic precaution, cannot be overesmated. On the other hand, it must not be forgotten that in pasteurized ilk the organisms which produce sourness and thus give warning of danger re likely to be killed, while certain spore-bearing organisms that produce utrescence and decay, survive. The presence of these organisms in paseurized milk is far more objectionable than the presence of the lactic acid rganisms in unpasteurized milk. In fact, the vigorous growth of the oranisms that produce sourness may suppress or destroy the activity of those rganisms that produce decay.

Pasteurization at Home and under Scientific Control.—Home paseurization of milk is not advisable if a competent municipal supervision of the rocess can be secured. Municipalities should maintain pasteurizing depots, t least for the use of infants, and these should be so supervised that the milk ntering them is as pure as possible before pasteurization, and is then properly asteurized, cooled, sealed, and prepared for delivery. No better service ould be rendered by a municipality than to thus make the best of bad condiions, where the milk supplies are not ideal. If the milk is produced at home, as is the case on the farm, then pasteurization is rarely necessary, as fresh milk can be obtained at all hours for the infant, and should always be used. Even at the present time, people living in cities who have places where they could keep a cow very commonly secure a cow, or a goat, to provide the milk for the infants of the family. This is, of course, advisable if cows and goats can be kept under sanitary conditions, but only the very rich are able to do this in cities, since there must be yards large enough to secure sufficient ventilation

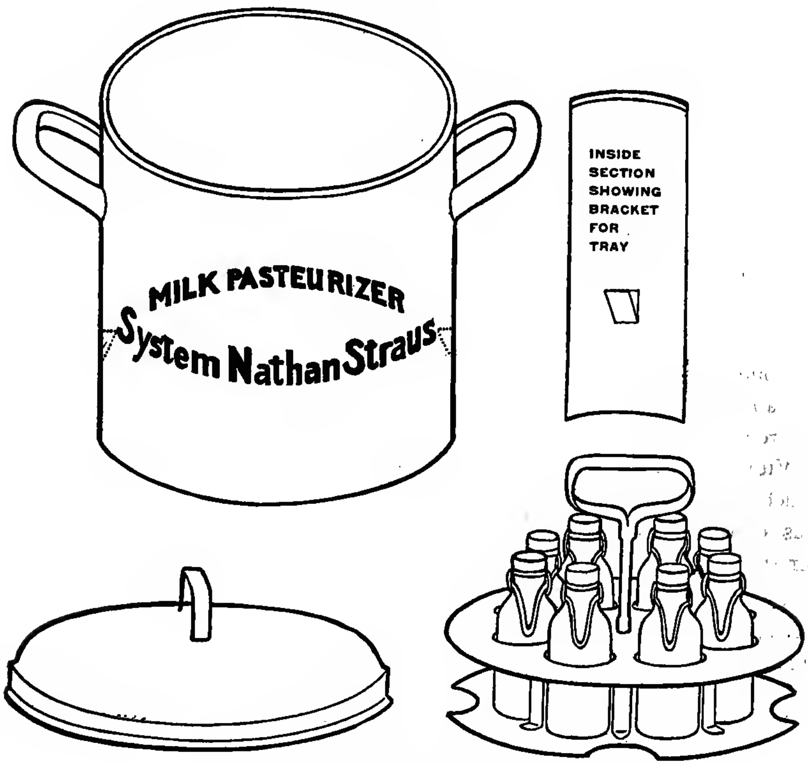

FIG. 87.—THE STRAUS HOME PASTEURIZER.

and exercise for the animals. The constant confinement of a cow or goat in the stall or the stable cannot be regarded in any sense as an ideal condition for the production of pure milk.

The Straus Home Pasteurizer.—A simple method for home pasteurization which can be practiced where city supervision fails has been devised by Straus. The apparatus is shown in the accompanying illustration. The directions for using this pasteurizer are as follows:

1. Use only fresh, filtered milk, which has been kept cold, and proceed as follows:

2. Set the bottles, after they have been thoroughly cleaned, in the tray, fill them to the neck, and put on the corks or patent stoppers.

3. The pot is then placed on a wooden surface (table or floor) and filled to the three supports (in the pot) with boiling water.

4. Place tray, with the filled bottles, in the pot so that the bottom of the tray rests on the three supports, and put cover on quickly.

5. After the bottles have been warmed up by the steam for five minutes, remove the cover quickly, and turn the tray so that it drops into the water. The cover is to be put on again immediately. This manipulation is to be made very quickly, so that as little steam as possible can escape. Thus it remains for twenty-five minutes.

6. Now take the tray out of the water and cool the bottles with cold water and ice as quickly as possible, and keep them at this low temperature till used.

7. Before use, warm the milk—in the bottles—to blood heat. Never pour it into another vessel.

8. The milk must not be used for children later than twenty-four hours after pasteurization. Never use remnants.

9. The advantages of pasteurization over other systems, such as sterilization or boiling, consists in the lower degree of heat applied, which is sufficient to kill all noxious germs, while the nourishing quality and good taste of the milk are retained.

Views of Nathan Straus on Pasteurization.—Mr. Straus has devoted much time and money to improving the quality of city shipped milk and has established many municipal pasteurizing plants. In a paper prepared for the Seventh International Congress of Applied Chemistry he says:

An epoch in life saving is marked by the assembling in London of the Seventh International Congress of Applied Chemistry, for the workers in that branch of chemistry which has to do with the purity of foods have won the right to celebrate the triumph of their science over commercial greed.

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But my interest in the science of applied chemistry is due to the aid given me by your profession in my life work of saving the lives of babies.

For eighteen years I have done what one man could do to stop the slaughter of children. In 1892 I was convinced that infected milk was responsible for the excessive infantile death-rates and for the persistence of tuberculosis among human beings.

Forthwith I proceeded to put pasteurized milk within the reach of the children of New York city. Instant was the response in decreased mortality, and conclusive was the demonstration obtained by feeding the city waifs on Randall's Island with pasteurized milk, resulting in the reduction of the death-rate from 44 percent to 19.8 percent. Therefore I proceeded to urge both in America and in Europe the adoption of pasteurization as a practical means of killing pathogenic germs in milk and saving children from disease and death, doing what I could to facilitate the putting of such milk at the disposal of mothers.

Instantly my work was bitterly opposed. In those days I could only point to the babies fed upon pasteurized milk to prove that I was right. Objections to pasteurization multiplied, based entirely upon ignorance or hostility at the idea of a mere layman teaching how to save lives.

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However, throughout all these years, with no purpose but to save lives, I was compelled to be on the defensive, and the extension of the benefits of pasteurization was hindered everywhere by the noisy clamor of those who did not know and who would not believe.

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Such was the condition when applied chemistry stepped in to determine scientifically the value of pasteurization and the true weight of the objections shouted from the housetops by its foes.

I submitted, with perfect frankness, to the Public Health Service of the United States in 1907, every objection that I had ever heard raised against pasteurization, every alleged disadvantage, every criticism, and I asked nothing but that each of these objections should be carefully considered, and that a true scientific verdict should be rendered.

The result was given to the public last year in the famous Hygienic Laboratory Bulletin No. 41, "Milk and its Relation to the Public Health," which was a complete and thorough vindication of pasteurization, proving scientifically that the heat necessary to kill the germs of disease does not impair the ferments necessary to digestion, does not deteriorate the quality of the milk or lessen its food value, does not alter its chemical or physical qualities, and does prevent much sickness and save many lives.

In short, the experts working in the investigation of the milk problem experimentally demonstrated the scientific correctness of pasteurization as the practical method of making milk safe food, confirming my practical experience of eighteen years in two hemispheres, and I take this opportunity to express my sense of the obligation that humanity thus owes to applied chemistry for sweeping away the crude errors and noisy ignorance that has so long protected the pathogenic germs in milk and thus enabled them to spread disease and death broadcast.

The importance of this addition to the sum of human knowledge can be appreciated only by one who has tried to stand between disease and the babies and to shield them from untimely death.

When the results of this American investigation are properly grasped by the medical profession and by the officers charged with the protection of the health of nations and communities, it will be held to be a crime to sell milk unless it has been produced under sanitary conditions from tuberculin-tested herds, and delivered uncontaminated in sterilized containers, or unless it has been properly pasteurized.

Hundreds of thousands of lives will be saved if this Congress will make a clear and emphatic declaration for pasteurization as the scientifically correct and practically efficient method of saving human beings from tuberculosis and other milk-borne infections. I sincerely hope that the great influence of the International Congress of Applied Chemistry will be exerted in the cause of health and life and against disease and death.

Commercial Pasteurization of Milk.—The commercial pasteurization of milk has greater or less efficiency according to the care with which it is practiced. B. R. Rickards, formerly director of the Boston Board of Health Laboratory, in a paper read before the American Public Health Association, has called attention to the temperatures which are attained during the process of pasteurization. The temperatures observed by him varied from 140° to 165° F., and the time of exposure to the highest temperatures varied from three to twenty minutes. It is stated by Rosenau that exposure for two minutes at 140° F. is sufficient to kill most of the pathogenic bacteria producing diphtheria, typhoid, and dysentery, but at least twenty minutes at 140° are necessary to kill the tuberculosis germ.

As to the efficiency of pasteurization of a commercial character, it is found by Rickards to vary from 92.4 percent to 98.9 percent. In other words, the percentage of organisms present which are killed by the pasteurization varies within the limits mentioned.

Growth of Organisms in Pasteurized Milk.—Attention is called, however, to the very great rapidity with which organisms increase in unpasteurized milk. For instance, in twenty-four hours at the temperature of the ice box the number of organisms in pasteurized milk increases 8400 percent, while the number of organisms in unpasteurized milk increases only 2100 percent, showing four times as rapid an increase in the pasteurized as in the unpasteurized milk.

Pasteurized milk keeps a long time, but eventually acquires a strong odor and may reach rather advanced stages of decomposition without turning sour, and this, of course, is an element of danger. In almost every case reported by Rickards the pasteurized milk, although heavily loaded with bacteria, did not decompose until after the unpasteurized milk taken at the same time had curdled. It is evident that such milk, apparently sweet, must be decidedly unfit for feeding infants.

Results Obtained in Boston.—The conclusions reached by Rickards are presented in the "Medical Officer" of London for November 6, 1909, as follows:

1. A large amount of milk is pasteurized in Boston every day. Some of the milk of one contractor is pasteurized in the country and is again pasteurized in Boston.
2. The percentage of milk pasteurized is probably increasing.
3. Some of this milk is of very high bacterial content.
4. Bacteria will increase much faster in pasteurized than in unpasteurized milk.
5. The pasteurization of milk affects the microscopic estimate of bacteria and leucocytes.
6. Commercial pasteurization of milk without restriction puts a premium on dirty milk, since dirty and old milk, otherwise unsalable, can then be put on the market.
7. Pasteurized milk may well mean cooked dirt, cooked dung, and cooked bacterial products; and the laboratory is powerless to detect it unless apparent to the naked eye.

8. The commercial pasteurization as at present practiced in Boston probably would destroy all disease-producing organisms, with the possible exception of the bacilli of tuberculosis. The latter would probably be killed in the majority of instances. One machine only out of the three tested would be likely to destroy the latter. The toxins produced by these and by the putrefactive organisms in dirty milk would undoubtedly escape unharmed, and in many cases be capable of producing severe intestinal disturbances, especially in babies.

9. A false sense of security is undoubtedly conveyed by the term pasteurized milk. The lack of security may come from either improper pasteurization, the pasteurization of improperly handled milk, or improper care of pasteurized milk.

10. The unrestricted pasteurization of improperly kept, old, or dirty milk should be prevented by regulations or ordinances prohibiting the pasteurization of milk containing over a certain specified number of bacteria per cubic centimeter, the bacterial limit being set with due regard to local conditions, especially the distance from which the milk comes. Such regulation should, of course, be coupled with a regulation forbidding the sale of milk above the bacterial limit established.

11. The law should require that milk heated above 140° F. should be marked heated or pasteurized milk. Pasteurized milk should not be sold as fresh milk.

The pasteurization of milk in itself is probably not a harmful process, and is, perhaps to a certain extent, a necessity under modern conditions in large cities, but commercial pasteurization should be carried on only under the most stringent supervision.

Changes due to Superheating Milk.—A work on the hygiene of infancy by Dr. Variot has just been presented to the French Academy. The following remarks were made at the time of presentation by Prof. Gautier:

As a result of observations based upon several thousand young infants, Variot asserts that the superheating of milk to a temperature of 108° to 110° C. (about 230° F.) renders it more digestible than even fresh milk. The cow's milk thus prepared gives soft coagulations, easily broken up and readily lending themselves to the action of digestion. Although its long use presents certain disadvantages, especially in producing constipation and swelling of the abdomen, cows' milk thus sterilized is generally better suited to the bringing up of infants than crude milk corresponding thereto. It is certain that milk superheated to this degree saves a multitude of children unfortunately deprived of mother's milk.

Variot in this statement takes no account of the changes in the constitution of a milk due to heating and their possible effect on infant nutrition.

CONTROL OF THE MILK SUPPLY.

Sources of Pure Milk for Infants.—There are two or three points that are of prime importance in the selection of a dairy for producing milk for infant feeding. In the first place, it must be located in a country that produces dairy cows of high grade and efficiency. By reason of natural advantages, such as the character of the pasture and its continuity during the grassy season, certain parts of the United States have been found to be more suitable for the establishment of dairies than others.

The same difference obtains in other countries, and experience has shown that northern sections are more suitable, as a rule, for dairying than those farther south; not only is the grass more abundant, more nutritious, and more persistent, but the cows are less annoyed by flies and other insect pests, are kept in better health, and produce a higher grade of milk. Undoubtedly, the region of Normandy is most famous for the character of the dairies and the dairy supplies which are produced. The surroundings of the cow are of equal importance, and there must be plenty of shade in the pasture and an abundance of fresh water in order that the cow may produce a milk suitable for infant feeding. Not only should the environment of the cow be such as has been described, but the animal itself must be healthy and free from any disease, especially tuberculosis. Frequent testing of the herds is necessary, in order to guard against this disease. The more the cow lives in the open, the less is she subject to tuberculosis. For instance, the climate of Normandy is so mild that the cows are not even stabled for milking. Experience has shown that high breeding, which means indoor breeding, usually renders an animal more subject to tuberculosis than an ordinary one would be. For instance, the high-bred Jersey is much more prone to tuberculosis than the native cows of the mountains or woodlands. For this reason a grade cow or any ordinary cow might be better suited for the production of milk for infant feeding than a higher grade Jersey or other breed. When possible, the milk for infants should be that of a herd rather than of a single cow. The principal point, however, is to secure first of all cows free from disease, and then to keep them in such ideal quarters as to make infection practically impossible.

Control of Milk Supply for Large Cities.—It is easy, as may be seen, to secure proper control of a milk supply for a farm or for a small village in the country, but when great units are considered, such as London, Paris, Berlin, or New York, the problem becomes extremely difficult. The keeping of cows within a city should certainly be prohibited by law. It has been said that in some congested quarters of New York city cows have been found even on the third and fourth floors of tenement-houses; these animals never see the sunlight or get a breath of fresh air from year to year. Whether this is an actual condition or not, it illustrates the extreme of what should not happen. The cow without a pasture is not a suitable animal to furnish milk for an infant, no matter where she may be found.

The very fondness of the farmer for his stock sometimes leads to injury. Stables which are so constructed as to exclude the air and thus remain very warm during the winter are not as apt to result in healthy milk as the one which by means of numerous cracks or vents permits the free passage of air, cold as it may be. Stables, therefore, should be constructed with as perfect ventilation as can be secured, even if some slight discomfort should arise therefrom for the animal herself. A cow will naturally endure great extremes of temperature if she has not been inured to luxury by protection during her growth.

Certified Milk.—The ideal milk for use of infants in large cities is, undoubtedly, the certified milk. Adults may drink milk of a quality which would be almost fatal to an infant and suffer therefrom no appreciable harm. I do not mean to convey the idea that adults are not entitled to pure milk, but the point which is to be accentuated is that impure milk may not harm an adult seriously and yet may kill an infant. If the quantity of certified milk, therefore, is to be restricted, that which can be obtained should be devoted to infant feeding. The municipal authorities might well take action along these lines, requiring infants to be fed only with certified milk in all quarters of the city. As this would bear heavily on the poor, it would be a wise expenditure of the public funds to provide the difference in price between the low-grade milk which the poor person otherwise would secure and the high-grade milk which the law requires him to use. In other words, if a poor man can get milk of a low grade for six cents a quart, municipalities should see to it that when infants are in the family a sufficient quantity of certified milk should be provided, although the price to be paid by the poor family might not be greater than the six cents, the difference being made up from the municipal treasury. Thus there would be no direct giving of pure milk to the poor man's child, as he would still be required to pay the same amount which he was paying for the dangerous milk. Many cities have undertaken, through public-spirited men and associations to supply milk of this character. Notable among these is the New York Milk Committee, organized for the purpose of securing, if possible, pure milk for the poor children of New York.

Inadequacy of Certified Milk.—According to some authorities the idea that all the ills due to imperfect milk may be remedied by a proper supervision of stables and dairies is not wholly warranted. Unhappily perfect control is not often obtained, and the chief objection to certified milk comes from the indifference of the producers. If the milk is in charge of a person enthusiastically devoted to the production of pure milk, and who has ample means to carry out his ideas, little is to be feared. If, however, certified milk is furnished without adequate hygienic control many of the precautions which are necessary may be omitted and injury done before the fault is discovered. Some authorities even advise the pasteurizing of certified milk, but in this case they do not take into consideration the objections which have been raised to such pasteurization. According to some authorities it tends to derange nutrition, especially of the bones. Among those who have opposed pasteurization may be mentioned the Illinois State Board of Health, which has pointed out the danger of the development of rickets in infants fed on such milk.

Influence of Pure Milk on the Death-rate.—Every one has recognized the fact that pure milk, for infants especially, would diminish the death-rate, especially during the summer months, to a very perceptible extent. This reduction has been practically worked out by Dr. Goler, of Rochester, who has for years been interested in the milk supply of that city. An illustration of the effect produced by careful control of the milk supply is furnished in tabular form by Dr. Goler, in an article printed in the "Maryland Medical Journal" in January, 1906. The death-rates in July and August in Rochester are compared for a period of twenty years. The comparison is made for nine-year periods, namely, from 1888 to 1896 and from 1897 to 1905, inclusive.

	July Deaths.		August Deaths.	
	Under 1 year.	1 to 5 years.	Under 1 year.	1 to 5 years.
1888,	90	28	118	25
1889,	133	18	83	24
1890,	88	18	94	18
1891,	81	15	93	17
1892,	101	26	104	34
1893,	99	16	85	19
1894,	82	12	72	29
1895,	92	16	56	11
1896,	108	18	59	17
Totals,	874	167	764	194
General total,	1041		958	

	July Deaths.		August Deaths.	
	Under 1 year.	1 to 5 years.	Under 1 year.	1 to 5 years.
1897,	43	7	44	13
1898,	47	11	47	10
1899,	51	33	44	18
1900,	50	16	54	14
1901,	37	12	38	8
1902,	26	5	43	20
1903,	32	16	34	18
1904,	15	11	43	6
1905,	53	10	60	13
Totals,	354	121	407	120
General total,	475		527	

Total deaths under five years, July and August, first period, nine years, without municipal milk stations, 1999

Total deaths under five years, July and August, second period, nine years, with municipal milk stations, 1002

Conclusions.—No more striking evidence of the effect of the control of the food supply on infant mortality could possibly be given than these figures. While it is more than probable that a part of the conservation of the infant life is due to general improvements in medicine and sanitation, and not all to the milk supply, yet I think no one would deny that the latter is the dominant factor in diminishing the death-rate. When one considers for a moment that the death-rate of children under the age of five years has been diminished by nearly one-half in the city of Rochester alone, under the influence of sanitary food, sanitary surroundings, and progressive medicine, it is plain that it is almost criminal on the part of the rulers of large cities to permit the old system of child slaughter to go on. It may be thought that the death of an infant before it has any economic value is of small importance. This may be a consoling doctrine when the case is looked at solely from the point of utility, and yet even from this point the argument is faulty. It is true that a child under five years of age has no economic value, but there is an expenditure of an economic character in bearing and caring for children under five years of age. The whole amount so invested is lost by the death of the child. But when we consider the higher motives and the importance of saving the child to the family, the sorrow of the parents, and the general depressing effect of disease and death, there is no excuse left for the authorities of municipalities who still permit the old death-rate to continue.

Under the influence of progressive medicine and the advance of science, nearly all communities have made great improvements in the care of milk for infant uses, and yet, perhaps even in Rochester and other cities as well kept, still greater improvements might be made and the death-rate still further lowered. There is every incentive to sanitary science and medical skill to develop to the utmost all the means which man can command to protect the life of the human family in its most tender years, for if the infants can all be saved, the average length of life of the human race will be immensely increased, even should the grown man not live longer than he does today.

INVALIDS' FOODS.

Care of Food.—Special care should be exercised in connection with the keeping of infants' and invalids' foods to avoid the possibility of deterioration and infection after the food has reached the house. What is true of sanitary precautions respecting infants' and invalids' foods applies with equal force to foods of all kinds.

Absorption of Bad Odors.—Butter, cream, and milk especially should not be exposed to the odors of other foods, as they absorb these odors and hold them with tenacity, so that in consumption they give rise to unpleasant sensations of taste and smell.

Care of the Ice Chest.—At all times, but especially during hot weather, the greatest care should be exercised that the cooler or ice chest is kept in a sanitary condition. In the construction of a cooler of this kind it is advisable to have as few sharp corners or other receptacles where impurities can congregate as possible. Coolers made with curved joints and of glass or enameled materials, so as to prevent the absorption of moisture or of objectionable organisms, are to be preferred.

The cooler must always be kept scrupulously clean and this can best be done by removing the contents very frequently and thoroughly washing and sterilizing the food receptacles, and in fact all parts of the cooler. By scrubbing with hot water and subsequently exposing the interior of the cooler, while still moist, to the fumes of formaldehyde or of burning sulphur complete sterilization and sweetening of the interior of the cooler can be secured. Before restoring the food, any fumes of sulphur or formaldehyde remaining should, of course, be removed by leaving the doors open for a proper time.

Protection from Dust.—Infants' and invalids' foods, as well as others, should be carefully protected from dust, and when not in the cooler they should be well covered. Glass covers are preferable for this purpose, and permit the condition of the food to be readily ascertained. Shelves on which these foods are kept should be perfectly clean and sanitary, and sterilized from time to time as directed for the ice chest.

Contamination by Domesticated Animals.—Foods should not be left where cats, dogs, or other animals of the house can reach them. Often the family dog and cat are admitted to too intimate association both with the members of the family and with the food supplies, and precautions should be taken to prevent any contamination from this source. Protection of foods from rats and mice might also be mentioned in this connection.

Danger from Flies and Mosquitoes.—The fly is the house pest which is most carefully to be watched. If the house is near the stable, the plague of flies is apt to be greatest, since they breed most profusely in manure heaps. Since the discovery of the activities of the mosquito in transmitting disease, greater attention has been paid throughout the whole country to the screening of dwellings in summer-time, and this screening of course is more effective in keeping out the fly than the mosquito. There is no excuse for the plague of flies which prevails in many households. It is better to exclude them by screening than to kill them, in any manner, after they may have gained an entry; but if it is difficult to drive all the flies out of the screened house, the use of fly-paper or a fly poison of some kind is advisable to destroy those that remain. The fly is one of the most common sources of food contamination, and should be rigidly excluded from the house, and especially from the kitchen. It is also believed to be a carrier of typhoid fever. The mosquito in some localities is even a greater pest than the house-fly. The mosquito breeds in stagnant water, in swamps and ponds, in vessels of water kept about the house and barn, and even in cisterns and wells. If the breeding cannot be prevented, screening is the next best remedy. The mosquito, although an intolerable pest, is not so apt to contaminate the food as the fly.

Sanitation in the Kitchen.—The kitchen and the larder should be kept clean and free from organisms with as much care as the cooler. All utensils employed in the preparation and transportation of infants' and invalids' foods should be absolutely sterile and free from dirt and dust of every kind. The kitchen which has an odor of stale food is not in a sanitary condition. Ventilation and cleanliness are the cardinal principles on which the kitchen should be conducted.

Classes of Invalids' Foods.—For convenience these foods may be divided into three classes: First, foods which are offered simply for building up and restoring the strength of the body, without specific reference to any particular disease; second, those which are intended for use in particular diseases where the food has some specific relation to the character of the disease; third, materials, perhaps hardly to be classed as true foods, which in themselves contain but little nourishment, but which by means of rapidity of absorption or of palatability are used more as stimuli in cases of extreme depression or inanition.

Disordered Nutrition during Illness.—Usually one of the first symptoms of illness is disordered nutrition. Loss of appetite is a symptom of almost every disease, and disordered digestion attends many of the ailments to which humanity is heir, other than those connected directly with digestion. In the treatment of many diseases, especially those of a chronic character, the problem of nutrition is one of the most important with which the physician has to deal. All physicians admit that medicine and physical or electrical treatments do not cure. The surgeon's knife simply amputates and removes the diseased part, but nature must restore the tissues and reëstablish normal conditions. When a disordered system is restored to health, it is due to natural causes, but these can be aided, promoted, and stimulated by legitimate remedies, electrical treatment, and proper nutrition. Hence, food is as much a part of materia medica as any drug.

Toleration of Food.—There is the widest divergence among the sick in their toleration of food. In some diseases, especially tuberculosis, there may be but little difficulty in tolerating the ordinary foods. In other cases, especially acute diseases of the digestive organs, certain ordinary forms of food which the patient relished when well become extremely objectionable to him in ill health. The ingestion of these foods then produces nausea and vomiting to such an extent that scarcely any nourishment can be retained in the stomach. In such cases it is the duty of the physician to endeavor by every known means to discover what the patient can tolerate. The patient's own taste in this matter sometimes leads to a proper selection of the food, but this cannot always be trusted.

Danger of Overfeeding.—In most cases care must be taken in the nutrition of invalids to avoid overfeeding. In some instances, however, it is claimed by leading physicians that overfeeding is advisable. This is especially true in a disease like tuberculosis. In diseases which are accompanied by fever the waste of the body is always abnormally rapid. In fact, fever is only the result of accelerated consumption of tissue; in other words, energized katabolism. Usually the high temperature is secured at the expense of the tissues of the body and not of the ingested food. This explains the rapid wasting away in all diseases accompanied with a high fever. To check this waste it is necessary to stop the disease, and to regain health the lost tissues must be restored. The object of feeding, therefore, in the case of sickness is twofold: First, to supply the body with as much nourishment as possible to assist in checking the progress of the disease by sparing the body tissues, and, second, to rebuild the tissues which have been torn down by the ravages of the disease. There is, however, a danger to be avoided in the case of an insatiable appetite following heavy destruction of the body tissues as in typhoid fever. Rupture of the intestinal walls and other troubles may ensue if the diet be too heavy or not fully cooked.

Ordinary or Natural Foods.—It is evident that in the case of invalids' foods the materials to be used are those ordinarily employed, and it is only necessary to modify them in their preparation and the relative proportions and quantities in which they are used. Selection also should be made of such foods as are easily digestible, and this leads to the first of the more important considerations, namely, the administration of liquid nourishment. Milk, of course, is most frequently used in such cases, but the preparation of other foods, so as to bring their soluble constituents into a form suitable for consumption, is highly important. In each case great care must be exercised in administering these preparations in small and often repeated quantities, in order to guard against injury. It is usually advisable to administer the juice of fruits instead of the fruits themselves. Great benefit frequently results from the use of the juice of apples, grapes, or other fruits. When solid food is administered, it should be in small quantities and in a proper state of subdivision, produced mechanically or by cooking, which renders it easily susceptible to the action of the digestive ferments. Soft-boiled eggs are very useful in many cases of this kind, and sour milk, either buttermilk or fermented milk, known as koumiss, is frequently of great aid, being more readily tolerated, as a rule, than sweet milk or cream.

While the partial or wholly digested foods are of value in sustaining life and bridging over brief periods of illness, they should not be given to a patient any longer than necessary, as the healthy organism is better nourished by a food in its natural undigested state than by a digested food. Further, it is well to give invalids a food that has been digested by natural means, that is by enzyms, rather than one in which the cleavage was brought about by artificial means, the latter appearing to differ somewhat in character from the former and the results to be less beneficial.

It is also important to select foods for invalids and infants which have a neutral or alkaline ash, as foods with an ash possessing an acid reaction are a constant source of drain on the available alkali of the body, leading to an excretion of sodium, potash, and ammonia and perhaps other available free alkali in combination with the acid elements of the ash. The ill effects of feeding corn and other foods with an acid ash has been demonstrated in the case of animals by several investigators.

Foods as a Cause of Disease.—That some foods are the direct cause of certain diseases, as well as predisposing causes in hundreds of other instances, is a well known fact. One of the most familiar illustrations of this fact is the case of scurvy, a disease which is due principally to the continued and exclusive use of cured foods, especially meats. The disease is removed only when the cause of its production ceases to exist, and fresh vegetables and fruits, particularly oranges, lemons, and grape fruit, form at least a part of the dietary.

Another mysterious disease which has long puzzled medical men is beri-beri, which occurs principally in rice-eating countries. Extensive investigations made as to the cause of this disease have indicated that it was seen in its greatest virulence among soldiers, and especially sailors, confined almost exclusively to a diet of rice. In other words, beri-beri holds the same relation apparently to rice as scurvy holds to cured meats. One of the most interesting of the modern developments, however, in the case of beri-beri is seen in the fact that it is now believed to be caused but rarely by natural rice, but rather by rice which has been polished. Polishing rice is a process whereby its outer coat is largely removed, and together with it the layer of phosphate cells found immediately beneath the external covering. Japan has succeeded in stamping out beri-beri from her navy by an improved dietary, while in Java the Dutch physicians have reported that a mixture of other foods with rice has vastly reduced the prevalence of this disease. Further than this, the Dutch physicians have found that when rice was eaten unhulled, namely, unpolished, the proportion of cases among the soldiers was only one in ten thousand, while, on the other hand, if the outer covering was entirely removed the proportion was one to thirty-nine. It is evident from this that one method of preventing the introduction of beri-beri into this country, where the consumption of rice is largely increasing, would be to forbid the importation of rice which had been polished or treated in this or a similar manner, and to forbid interstate commerce in such rice as having undergone a treatment which may render it injurious to health.

The following resolution was passed by the Biennial Congress of the Far Eastern Association of Tropical Medicine, held at Manila, March 5 to 14, 1910:

Resolved, That in the opinion of this association sufficient evidence has now been produced in support of the view that beri-beri is associated with the continuous consumption of white (polished) rice as the staple article of diet, and the association accordingly desires to bring this matter to the notice of the various Governments concerned.

Sour Milk and Longevity.—Many and extravagant claims have been made respecting the virtues of sour milk in the prolonging of life. It is claimed that the ferments which produce the acidity of milk are not only harmless in themselves, but are highly militant and eager to undertake a campaign of extermination against the pathogenic bacteria of the intestines. That sour milk is wholesome and palatable there is no manner of doubt. It is an item of nutrition of considerable importance, especially on the farm where the old-fashioned method of making butter still prevails.

Misleading conclusions have been drawn from the studies of many investigators, especially of Metchnikoff, respecting the virtues of sour milk, and the most extravagant claims are made respecting its ability to prolong life. Even if this faculty of sour milk were apparent, it is entirely too soon after its discovery and promulgation to base any experimental conclusions upon it. It requires, of course, more than eighty years to determine whether or not sour milk will prolong life. The fact that people who consume sour milk live to a ripe old age is of no consequence, since a great many who do not drink it do the same. The only valuable experimental evidence would be to begin with a colony of infants, nourished in the ordinary way, both during infancy and when grown, and another colony of a similar number, nourished in the usual way and afterward fed constantly and largely on a sour milk diet. The determination of the respective lengths of life of the two groups, not of individuals thereof, might finally be considered as a demonstration of the value or lack of value of a sour milk diet to prolong life. But whatever the real merits of the case may be, there is no doubt of the great interest in the matter at the present time.

Some of the sour milks which have been long known have already been spoken of, such as koumiss and kephir, and there are many others. These terms are usually the names of sour milk in the several countries in which they have been largely used. Lately there has been discovered an organism, *Bacillus Bulgaricus*, which is said to have peculiarly developed the properties of souring milk. It is claimed also that the Bulgarian bacillus, so called, does not produce alcohol, nor any other injurious substances which too often attend ordinary yeast and bacterial fermentation. Further, it is claimed that this bacillus has no action upon the albuminoids of the milk nor on the fats. If all of these assumptions are true, then it is certain that the *Bacillus Bulgaricus* will prove one of the most useful agents for souring milk yet discovered, especially if it can be acclimated to the digestive tract. In this case it might prove of great benefit in the way of arresting pernicious fermentations and putrefractions. In point of fact, all kinds of bacterial flora flourish in milk, and it is rather difficult to cultivate one at the expense of the others unless it be one of such a vigorous life as to practically preclude the growth of other less fortunately endowed organisms.

Preparations of this bacillus are now offered, with the assurance of the purity of the cultures and the activity of the ferments. The *Bacillus Bulgaricus* is said to produce lactic acid, not only from milk sugar, but also from ordinary sugars, such as cane sugar, maltose, levulose, and dextrose. For this reason the cultures of the bacillus can be made not only in milk, but in vegetable broths or other preparations which contain sugars on which they can act.

Already many certificates are found in the public press and in advertising literature of the virtues of sour milk specially prepared by some particular process like that described for preparation of the *Bacillus Bulgaricus*. Naturally, as in other cases of the same kind, these certificates must be considered *cum grano salis*. For instance, in Bulgaria, where this bacillus flourishes and where sour milk is used in large quantities, it is stated in some of this advertising literature that centenarians are extremely common, some of whom are said to have lived chiefly on a milk diet. An example of one case, Marie Priou, who died in 1838 at the age of one hundred and fifty-eight years, shows that she lived for the last ten years of her life entirely on cheese and goat's milk. This, however, would not prove much, as it appears she lived for one hundred and forty-eight years on an ordinary diet and thus had already established a reputation for longevity. It is doubtless true that many people who have lived to extreme old age have used milk largely as a diet, and sour milk at that. On the other hand, it is perfectly certain that many other people who have used milk and sour milk chiefly as a diet have died early in life.

One of the most interesting of these surprising statements is the following:

> In the village of Sba, in the district of Gori, there is an old Ossete woman, Thense Abalva, whose age is supposed to be about one hundred and eighty years. This woman is still quite capable and looks after her household duties and sews. Although she is bent, she walks firmly enough. Thense has never taken alcoholic liquors. She rises early in the morning, and her chief food is barley bread and buttermilk, taken after the churning of the cream.

There are perhaps other factors besides the buttermilk which have contributed to the extreme age of this old woman; her abstinence from alcoholic beverages and the use of barley bread ought not to be left out of consideration.

Another one of these instances of long life due to sour milk reads much like the advertisement of a certain whiskey. It is as follows: "Mrs. Jenny Read, an American, has written to me that her father, eighty-four years old, owes his health to the curdled milk which he has taken for the last forty years."

These instances are taken from the works of Metchnikoff and hence have received much greater vogue than they otherwise would have done. This authority, however, realizes that a great many other factors besides sour milk tend to promote health and prolong life. He says:

> If it be true that our precocious and unhappy old age is due to poisoning of the tissues (the greater part of the poisoning coming from the large intestine, inhabited by numberless microbes), it is clear that agents which arrest intestinal putrefaction must at the same time postpone and ameliorate old age. This theoretical view is confirmed by the collection of facts regarding races which live chiefly on sour milk, and amongst which great ages are common. However, in a question so important, the theory must be tested by direct observations. For this purpose the numerous infirmaries for old people should be taken advantage of, and systematic investigations should be made on the relation of intestinal microbes to precocious old age, and on the influence of diets which prevent intestinal putrefaction in prolonging life and maintaining the forces of the body. It can only be in the future, near or remote, that we shall obtain exact information upon what is one of the chief problems of humanity.
>
> In the meantime, those who wish to preserve their intelligence as long as possible and to make their cycle of life as complete and as normal as is possible under present conditions, must depend on general sobriety and on habits conforming to the rules of rational hygiene.

From the above it will be seen that after all Metchnikoff is not yet willing to say that the consumption of sour milk is the sole or even the chief factor in the prolongation of life.

Advertising Claims.—It is unfortunate that scheming manufacturers have taken advantage of this possibility without waiting for any convincing demonstration and are offering to the public what are said to be pure cultures of the *Bacillus Bulgaricus*, with lists of diseases in which its use is efficacious. For instance, the following diseases, among others, are said to yield to the treatment of this bacillus: Eczema and all diseases of the skin, diarrhea, dyspepsia, dysentery, typhoid fever, sick headaches, all complaints of the liver, malaria in all of its forms, diabetes, Bright's disease and other diseases of the kidneys, rheumatism, gout, sclerosis, atheroma, senility, all diseases due to uric acid, all kinds of gastro-intestinal disturbances. All statements similar to those above can only serve to bring the whole subject of the use of sour milk into deserved contempt.

As the pure culture of the bacillus is not at all pleasant to the taste, it is recommended that it be administered by masking it with sterilized water, carbonated or plain, a little sugar, or any saccharine or other sirup, with some powdered cinnamon, or crumbs of dry black bread, such as pumpernickle; in other words, some vehicle to mask its acidity and unpleasant taste.

Summary.—It would be quite out of place in a work of this kind to either recommend any proprietary food or specialty, or to say anything derogatory thereto, and therefore I am considering only the general principle and not any particular preparation. The summary of the present condition of the sour milk agitation, it seems to me, is this. Sour milk has from immemorial times been used and appreciated by man. It is, doubtless, a wholesome, palatable, and nutritious form of milk diet. Sour milk can even be tolerated when sweet milk is extremely nauseating and objectionable and in such cases of deranged nutrition its administration is highly advisable. That it acts in any specific way in protecting the body against the dangers of intestinal putrefaction remains to be proved. It may do so in a general way, as does any good food which is palatable and easily digested. To this extent its utility cannot be denied. That it will have any general specific effect in prolonging human life is a matter which is wholly speculative. It may be said that care in the selection of foods, so that they may be all of the best and purest and freshest, will doubtless tend to prolong life. Milk is one of the most important of human foods, and hence its presentation in the most palatable and digestible manner is of the highest consequence, and when so presented, it will, doubtless, tend to prolong life. It is, however, entirely beyond the scope of our present knowledge to affirm that sour milk, as such, is a protection against premature death.

Preservatives in Fruit Juices.—As fruit juices are used quite extensively, especially grape juice, for invalids, the following statement made in the "Zeitschrift für öffentliche Chemie," February 15, 1910, in regard to the action taken in Saxony forbidding the use of preservatives in such products is of interest:

From the point of view of the nutrition of the people and the control of food products, weighty suspicions are aroused against the use of preserving materials in the food industry, with the exception of alcohol, as recommended by the Chamber of Commerce of Dresden on the third of September, 1909; even if the use is restricted, as suggested by the Chamber of Commerce, important objections are raised to this practice. Science does not possess sufficient experience and experimental data on a single substance to be able to state definitely the amount per hundredweight which would be non-injurious and therefore allowable. Further, after allowing a designated preservative to be added to fruit juices, the same would have to be allowed for all foods on the market. The result would be a flooding of the markets with all sorts of preparations which had been preserved in like manner as the fruit juices, for instance, milk, beer, butter, and preserves of all kinds. A public statement as to the non-injuriousness of x milligrams of salicylic acid or boric acid in fruit juices would therefore entail the general use of these bodies in foods and condiments.

This, however, would be lamentable from the standpoint of the interests of human health, and also from the standpoint of honest trade. Further, there would be an encroachment on the food control, as has been suggested by the Chamber of Commerce, which would not be reconcilable with the imperial prohibition of the addition of salicylic acid, boric acid, benzoic acid, and formic acid to wine, or even to drinks containing wine, and of salicylic acid and its compounds to meats. The Minister of the Interior, therefore, does not find himself in position to take a step which would permit the introduction of the above-mentioned preserving substances into the food industry, all the less so because to the makers of the fresh fruit juices there is a choice between pasteurization and the addition of alcohol, processes which up to the present time have been demonstrated as useful in the preservation of these foods. The fear that the high price of alcohol would make its use in the manufacture of fruit juices impossible in the future, the Minister of the Interior, in view of the price of the production of the spirit, cannot share.

FOODS USED AS DRUGS.

Medicinal Foods.—There is a large class of foods which are intended for the use of infants and invalids, which partake more of the nature of a medicine than of a food, to which the term "medicinal foods" is applied. Most of them are liquid or semi-liquid in form, and some are said to be predigested. They are, therefore, solutions which contain as their essential constituents small amounts of food substances, consisting chiefly of protein and carbohydrates, containing no, or very little fat, and usually preserved from decay by the use of alcohol or glycerol. The proteins have been converted into soluble material, that is, peptones or proteoses, by means of enzymic or chemical action. The carbohydrate constituent of these foods is either lactose or sucrose or starch which has likewise been converted into a soluble form, either by diastatic action or by an acid. Sometimes proteins may be converted into soluble forms by means of the action of acids, alkalies, or superheated steam, or all three combined. These and similar products are not, however, suitable for medicinal foods, that is, for the nourishment of those whose digestive and assimilative powers have been so weakened by reason of disease that it is not possible any longer to nourish them with the usual foods. Foods that have been rendered soluble by means of chemical and physical means are regarded by many physicians as toxic or at least dangerous as nutritive agents.

These foods have a varying composition, the protein in them ranging from less than 0.5 percent to more than 6 percent; the carbohydrates also range from about 0.5 percent to more than 15 percent, and the alcohol content varies from 12 to 19 percent by weight, while the percentage by volume, of course, would be considerably greater. As before stated, some of these foods contain large quantities of glycerol, used as the preserving agent instead of alcohol.

The Value of Medicinal Foods.—The value of medicinal foods depends on the protein and carbohydrate bodies contained therein. Glycerol does not, so far as known at present, possess any recognized food value, although there is a number of experiments on record to indicate that it influences metabolism. The food value of the alcohol contained in these mixtures is of doubtful nature. While it is true that in a state of health a man is able to oxidize a considerable quantity of alcohol, estimated by some at as much as three ounces of absolute alcohol per day, the ability to do this in times of extreme depression and weakness is doubtful. The alcohol, therefore, may act in a toxic manner rather than as a food. Hence it must be admitted that the presence of alcohol in such cases is to be looked upon as reprehensible, and this too without denying that in a state of health it may have some food value. In point of fact, the use of alcohol as a remedial agent is by no means so generally considered to be effective as in former times. There is a large and growing school of dieticians, including many learned members of the medical profession, who deny to alcohol the therapeutic value which heretofore has commonly been assigned to it. If, therefore, alcohol has neither therapeutic value nor can be assimilated in the stages of depressed vitality in which medicinal foods are resorted to, it can readily be seen that its presence is an unmitigated evil. In no case can alcohol act to build up the tissues, which is the effect most desired in cases of pronounced anemia and emaciation. What value the soluble protein and soluble carbohydrate may have in such cases is, therefore, likely to be counterbalanced by the evil effects of the alcohol present.

Studies of Council on Pharmacy and Chemistry.—The Council on Pharmacy and Chemistry of the American Medical Association has made a study of these foods, and has found that some of them possess less than one-sixth the nutritive power of milk, while the best of them have a nourishing power but little greater than that of milk itself. The Council has, therefore, decided that no liquid medicinal, or so-called predigested food, should be given consideration which contains less nutritive value, exclusive of alcohol and glycerol, than milk, and that at least one-fourth of this value must be in its nitrogenous constituents. It should be remembered that to sustain the equilibrium of a patient during a serious illness and prevent a waste which threatens death, not less than two quarts of milk, having a food value of 1430 calories, are required per day; to give a patient this amount of nourishment in the form of the medicinal foods alone would require the exhibition of such a quantity of liquid as would keep the patient in a state of continuous intoxication, even if it could be tolerated. If the small doses which are usually prescribed are given, the patient will be, undoubtedly, on a starvation diet, and thus suffer great injury when his friends and even the physician may think he is being nourished. Plainly, the only use of these foods, if they are to be employed at all, is in connection with a diet of milk or other ordinary food. The composition of some of these medicinal foods is given further on.

MEAT PREPARATIONS.

Meat Juices.—The juices of fresh meats, prepared in the home, are often found to be extremely palatable and to have some food value. The supposition that meat juices are highly nutritious is erroneous, but they are quickly digested and absorbed. On account of the tendency of meat juices to decompose it is advisable in all cases, if at all possible, to have them prepared immediately before using at the home. The quantity of juice which may be pressed from meat is not very great, but there are many little presses on sale which can be utilized for this purpose. If cold pressed meat juice is not required, the meat may be warmed to a moderate temperature before pressing; care should be exercised, however, not to apply a temperature approaching the boiling point of water, as this will coagulate some of the substances in solution. An excellent preparation is obtained by grinding the meat very finely, adding a little water, and allowing the preparation to warm gently on the stove below the boiling point before pressing.

Commercial Meat Juices.—Many preparations of meat juices are found on the market in various forms. The chief objection to them is that they must be preserved in some artificial way. The age of the preparation and the character of the preservative often make such foods more harmful than helpful. Pasteurization or sterilization is not suitable for the preservation of meat juices because of the coagula formed by the high temperature. A prepared meat juice will probably be preserved either by salt, glycerin, alcohol, or a chemical preservative which must necessarily be consumed with the juice itself. I think it will not be denied that all such methods of preservation are injurious to an invalid. The quantity of the preservative is often greater than the total nutritious substances of the juice, so that the patient does not get much nourishment but does get relatively large quantities of these preservatives in his food.

Impurities of any kind in any foods are to be deprecated, but their addition to or occurrence in foods of the sick, whose bodies are already depleted by reason of disease and abnormal conditions, is obviously inexcusable. To tax the system with the handling and excretion of ingredients which serve no good purpose is bad enough in the case of health, but in illness, when the vitality is low and the organs already overtaxed, it is a case of "whoever is not with me is against me"; the disastrous effects are apt to be swift and pronounced, and every precaution should be taken to insure that all food materials used are pure and unadulterated. The use of chemical preservatives and other harmful ingredients in invalids' foods is plainly criminal. In this connection attention is called to the action taken in Saxony in excluding preservatives from fruit juices as already mentioned.

Meat Extracts.—Meat extracts are more numerous than meat juices. A meat extract is a liquid or semi-solid obtained from meat, usually by heating and generally with the addition of water, though it may be made without. The average water content of the semi-solid extract is about 25 percent. Very little nutrient matter is extracted from meat by hot water, but the extract is pleasing to the taste, is rapidly assimilated, and in some cases is highly desirable, especially in tiding over crises in which the body does not need a great deal of nourishment, but must get it quickly. They are also useful in flavoring broths, etc. It is, of course, presumed that in the preparation of meat juices healthy animals are employed, though it cannot be said that this is always the case. Sometimes animals which are not suitable for eating, and yet not diseased, are used for the purpose of making meat extracts. Old bullocks which are too tough for beef purposes have been used very extensively for this purpose.

Commercial extracts are generally prepared by evaporating the water in which the beef for canning was heated, that is, they are a by-product in the preparation of canned beef.

The subject of meat extracts has been very extensively studied by Bigelow and Cook, who have published the results of their investigations in Bulletin No. 114 of the Bureau of Chemistry, U. S. Department of Agriculture. The samples which were examined by these investigators were purchased prior to the enactment of the Food and Drugs Act, and, hence, represent the character of goods which were on the market at that time. The analyses of the samples were submitted to the manufacturers for any comments which they chose to make upon them before publication.

Solid Meat Extracts.—There are some extracts of meat in which the liquid is evaporated apparently to dryness, and this enables the extract to be preserved with greater facility, and also diminishes the cost of transportation. Although the products are in a solid state they are by no means dry, containing from 12 to 26 percent of moisture. In the solid meat extracts the mineral constituents, of course, are very much concentrated. These consist of common salt together with the mineral constituents which are present in the extract, or which may be added in the course of manufacture.

For convenient study and inspection, Bigelow and Cook divide meat extracts into four classes, *i. e.*, solid meat extracts, fluid meat extracts, meat juices, and miscellaneous preparations. The analyses of these different classes are given in the table further on.

Substitutes for Meat Extracts.—Attempts have been made in the preparation of infants' and invalids' foods to substitute some less expensive material for meat extracts. The most promising substitutes which have been used are extracts of yeast, which are in some respects similar in composition to those obtained from meat. Yeast extracts are prepared by evaporation in vacuum cookers, resembling the method used in making meat extracts. In Germany preparations have been found consisting of a dilute preparation of meat to which a large amount of foreign protein, such as egg albumen, has been added. For many years yeast extracts have appeared on the market, especially in Germany, and have also been mixed with and used to adulterate meat extracts; their manufacture in the United States, however, has not obtained any great vogue, although it is claimed that small quantities are now made. When the aqueous extract of yeast is evaporated, especially in an open kettle, the color changes greatly and finely simulates that of meat extract. When the color is not deep enough in such cases, the use of caramel is resorted to in order to secure the necessary tint. Care is taken not to allow the evaporation to go too far, since otherwise bitter principles are formed, which in some respects resemble peptones, and which may be partially removed by washing with water and dilute ammonia.

The quantity of nitrogenous constituents in yeast extracts is smaller than in meat extracts. Some authors claim that their stimulating effect on the digestion is about equal in intensity, and as far as nutritive value is concerned, weight for weight of dry matter, there does not appear to be very much difference between them. The principal difference of a chemical nature between the yeast and the meat extract is found in the fact that the former contains no kreatin or kreatinin, while in the typical meat extracts from 10 to 20 percent of the total nitrogen is in these forms. The xanthin bases are also distributed differently in the two extracts. In meat extracts xanthin and hypoxanthin predominate, while in the yeast extracts adenin and guanin are the principal constituents.

Miscellaneous Extracts Intended for Invalids and Infants.—In the tables at the end of the chapter are found some miscellaneous compounds which are intended for infants and invalids. Among these may be mentioned the albumose and peptone powders, which are divided into two classes: first, those formed by the action of steam and acid on exhausted meat or other protein; and, second, powders prepared by chemically treating lean meat with hydrochloric acid and pepsin, by means of which all the fibrin, albumin, and gelatin are rendered soluble after being digested in water at a temperature of blood heat. These preparations may be more nutritious than the ordinary meat extract, but the methods of making the meat soluble are such as to throw doubt on the wholesomeness of the preparation. In fact it may be said that aside from the home-made meat juices or meat extracts there would be little loss to invalids if the standard preparations on the market were withdrawn.

Extracts from the crab and other crustaceans are also found, the crab extract being quite common in Germany. In this country there is quite a large sale for clam juice, which may, in some respects, be compared with crab extract. Other extracts prepared from fish, shrimps, clams, and anchovies are sometimes sold, but they are not of commercial importance.

Classification.—These miscellaneous compounds may be grouped for study according to certain characteristics of composition. In the first class Bigelow and Cook place extracts with high total kreatinin, approaching 10 percent, and a total meat base content of 40 percent of the total nitrogen. In these products the proteose and peptone nitrogen should include from 30 to 50 percent of the total nitrogen present. In class two are placed those miscellaneous preparations which have a proteose and peptone nitrogen content of above 50 percent of the total nitrogen. This class of bodies is low in both kreatinin and meat bases. Class three includes preparations low in proteose and peptone nitrogen and in kreatinin, but high in meat bases, while in class four are the extracts that are high in insoluble and coagulable proteid. In the above statements the kreatin is included with the kreatinin.

In several of these preparations but a small amount of meat extractives or bases are found. The data show that kreatin and kreatinin were absent in several cases, proving that the products in question were not made by the evaporation of an infusion of meat, and in some cases the total nitrogen was less than 1 percent. The stimulating effect of these compounds and the nutritive value of the nitrogenous bases are, of course, extremely small in all these cases. In fact, all of these liquid meat products, as far as nutrition is concerned, as has already been stated, are of little value, but they probably have uses in extreme cases of depression where a temporary stimulating effect is necessary in order that the digestive organs may be enabled to readily take care of more nutritious foods.

Addition of Gelatin to Meat Extracts.—It is doubtless true that the addition of gelatin to meat extracts has been practiced more or less in the past, as pointed out by Bigelow and Cook. By this means the manufacturer increased and maintained a certain nitrogen content, but supplied the nitrogen in a form lacking in stimulating effect and probably to some extent in nutritive value. Certain compounds, namely, tyrosin and tryptophane, are not present in gelatin, while they are found in true proteins. Gelatin alone is said not to support life in spite of its relatively high nitrogen content, while a true protein with a lower nitrogen content will. Gelatin, however, must be accorded some value as a protein-sparer. The buyer of an extract containing gelatins is, however, deprived of the characteristic essentials of a true meat extract, although the nitrogen content may be relatively high. In many cases only a small proportion of the added gelatin existed in the extract as such, as it was converted by the gradual process of hydration into gelatoses and gelatin peptones. But although gelatin as such is sometimes added to meat extracts, more frequently an extract prepared from bones to which some meat clings (which necessarily gives a product high in nitrogen due to the formation of gelatin from the bone) is mixed with straight meat extract, which contains little or no gelatin. Such preparations as these bone extracts are sold as second and third grades by the most reliable dealers.

Some gelatin may be formed in the preparation of a high-grade extract of meat, although with proper precautions there should be none present. When a sufficient amount of gelatin is present, it is readily detected by the setting qualities of the extract after warming. The power of gelatinizing is only possessed by unaltered gelatin; its dissociation products do not have this power. It is evident, therefore, that gelatin has no proper place in extracts of this kind, as it is totally different from them in its character and cannot be claimed to have the same stimulating effect for tiding over periods of great prostration as have the meat extracts. Bigelow and Cook conclude their studies with the following observations:

It is commonly assumed that proteids, gelatinoids, and the simpler amids have very different nutritive values, and, while all authorities would agree in assigning the highest value to the first of these, there is probably no small difference of opinion as to the order in which the second and third should be rated. In considering such a question, there should be separately taken into account relative digestibility or solubility, capability of undergoing osmotic absorption, and oxidizability for the production of energy. At present, no definite numerical statement of the relative nutritive values of nitrogenous bodies of these three classes can be made. It seems much to be desired that more extended experiments than have so far been recorded should be made upon living animals (as far as possible upon human beings) to determine the utilization of both the gelatinoids and the simpler amids. The latter no doubt undergo oxidation to some extent in the animal body, and produce some energy in consequence. It is probably true of these simpler amidic substances that much larger quantities than analysis exhibits as constituents of the food consumed, or than analysis detects among the residue of food rejected from the body without having undergone complete oxidation, may be constantly formed among the earlier products of the metabolism of the proteids, and afterward themselves undergo further change into the simpler and more stable forms of carbon dioxid, water, and urea.

In the animal body the amido acids are acted upon in two ways; that is, they are converted into the corresponding fixed acids or carbonic acid is split off, leading to the formation of Brieger's diamins, or it is possible for both of these processes to take place. Usually the albumins are converted in the alimentary tract by the four proteolytic ferments (pepsin, trypsin, erepsin, and arginase) into primary crystalline dissociation products, namely, the amido acids, which are absorbed in this form. Whether a part of the albumin taken as food can or cannot be absorbed in the form of albumoses, peptones, and peptids remains to be determined.

Meat preparations of the sort included in this report are largely used by the sick and the young. Their use is recommended frequently by physicians who may not have taken the trouble to ascertain the true nutritive value of the product prescribed. It seems to be the general consensus of opinion among scientific investigators who have studied this question that the food value of these meat extracts is rather limited, and although they are a source of energy to the body, they must not be looked upon as representing in any notable degree the food value of the beef or other meat from which they are derived.

When prepared under the best possible conditions, a commercial meat extract is, of necessity, in order that it may not spoil, deprived of the greater part of the coagulable proteids, which constitute the chief nutritious elements of the juice. It is fair to state that many manufacturers make no claim as to the food value of their preparations, only a comparatively few making extravagant statements as to the nutritive value of these products.

Preparations of this character are not wholly valueless in the sick room, for they possess stimulating qualities, and in the kitchen they are useful on account of their flavoring properties. They are not, however, concentrated foods, having, on the contrary, but comparatively little nutritive value. The meat juice prepared from fresh meat, in the home or hospital, by continued heating at a low temperature, is far superior as a food to the commercial meat extracts and so-called meat juices.

ANALYSES OF MEAT EXTRACTS, JUICES, AND POWDERS.

(*From Bulletin No.* 114, *Bureau of Chemistry.*)

SOLID MEAT EXTRACTS.

NAME.	MOISTURE.	MINERAL MATTER.	SALT.	TOTAL PHOSPHORIC ACID.	ORGANIC PHOSPHORIC ACID.	ACIDITY AS LACTIC ACID.	ETHER EXTRACT.	TOTAL PROTEIDS.*	TOTAL MEAT BASES.
	%	%	%	%	%	%	%	%	%
"Rex" Brand Beef Extract, ...	26.50	24.06	8.54	2.29	0.35	6.01	1.30	22.12	11.11
Liebig's Extract of Meat,	21.14	21.03	3.11	2.40	.61	8.13	.94	30.50	11.92
Armour's Extract of Beef, ...	21.66	20.46	5.47	4.55	.49	8.42	.50	27.51	9.52
Extract of Beef Premier (Libby, McNeill, and Libby), ...	21.86	30.92	18.32	2.53	.24	5.15	.53	14.93	9.98
Swift & Co's Beef Extract, ...	20.16	27.28	13.51	2.89	.18	4.15	.43	15.38	10.70
Beef Extract, Coin Special (Hammond Co.), .	12.39	31.68	13.25	3.19	.21	6.44	.43	15.01	13.14

FLUID MEAT EXTRACTS.

NAME.	MOISTURE.	MINERAL MATTER.	SALT.	TOTAL PHOSPHORIC ACID.	ORGANIC PHOSPHORIC ACID.	ACIDITY AS LACTIC ACID.	ETHER EXTRACT.	TOTAL PROTEIDS.*	TOTAL MEAT BASES.
Armour's Concentrated Fluid Beef Extract, . .	57.75	17.23	8.27	2.32	0.26	3.11	0.09	6.76	5.18
John Wyeth & Bro.'s Beef Juice, ...	58.84	16.21	6.71	3.27	.04	3.92	.23	6.45	5.99
Valentine's Meat Juice Co's Meat Juice, . . .	57.64	10.26	1.77	3.41	.45	4.53	.50	5.63	6.05
Vigoral (Armour & Co.),	49.94	15.91	7.02	3.29	.46	4.76	.04	10.75	6.30
"Rex" Fluid Beef Extract (Cudahy Co.), . .	55.99	16.99	8.48	2.48	.38	4.92	.05	7.00	8.21
Cibils Co's Fluid Extract of Beef, ...	64.63	16.13	11.38	.95	.14	2.43	.06	10.25	4.24
The Mosquera-Julia Food Co's Fluid Beef Jelly, ...	68.97	13.85	10.05	.80	.18	2.20	.09	8.13	3.06

* Sum of protein, proteoses, and peptones.

MEAT JUICES PREPARED IN LABORATORY.

(*From Bulletin No.* 14, *Bureau of Chemistry.*)

Preparation of Juice.	Water in Juice.	Mineral Matter.	Insoluble Proteid.	Coagulable Proteid.	Proteoses.	Peptones.	Amido Bodies.
	%	%	%	%	%	%	%
Round beef, cold pressed,	85.76	1.53	1.00	8.56	0.38	1.00	1.03
Chuck beef, cold pressed,	86.85	1.86	1.81	6.13	.44	.69	.90
Round beef pressed at 60° C.,	90.65	1.36	4.25		.25	.06	1.34
Chuck beef pressed at 60° C.,	91.90	1.29	.75	2.56	.44	1.31	.84
Juice from beef chuck at 60° C.,	89.56	1.27	3.06		2.63	..	.56
Juice pressed from sirloin steak and water,	91.10	1.40	3.38		1.25	1.13	.81
Juice extracted from sirloin steak by cold pressure,	96.13	.46	2.13		Trace	None	.44
Juice extracted from beef chuck by cold pressure,	96.58	.43	2.13		Trace	None	.28
Juice extracted from beef chuck by cold pressure after six hours at 60° to 100° C.,	98.11	.39	0		Trace	.75	.25

MISCELLANEOUS PREPARATIONS (MEAT EXTRACTS, JUICES, AND POWDERS).

(*From Bulletin No.* 114, *Bureau of Chemistry.*)

Class I.

Name of Preparation.	Water.	Mineral Matter.	Acidity as Lactic Acid.	Total Proteids.*	Insoluble and Coagulable Proteids.	Total Meat Bases.
	%	%	%	%	%	%
Bouillon Capsules,	14.75	39.75	5.80	22.19	2.06	6.93
Bovril, Seasoned,	43.39	16.09	3.87	22.06	7.56	6.02
Beef Jelly, Mosquera Extract of Beef,	27.82	17.31	7.53	28.63	1.19	9.24
Essence of Beef,	90.93	1.34	.88	5.07	.19	1.34

Class II.

Name of Preparation.	Water.	Mineral Matter.	Acidity as Lactic Acid.	Total Proteids.*	Insoluble and Coagulable Proteids.	Total Meat Bases.
Predigested Beef,	91.69	.18	.96	1.19	.06	.69
Soluble Beef,	30.15	14.55	5.46	37.76	3.19	6.68
Bovox Essence of Beef,	65.77	17.29	2.91	16.57	.19	2.78
Johnson's Fluid Beef,	47.22	9.80	4.86	31.75	7.56	3.87
American Brand Extract of Beef,	27.54	34.73	5.91	26.69	1.81	3.59
Bovinine Concentrated Beef,	80.40	1.55	1.22	14.14	3.38	.28
Essence of Mutton,	82.03	2.25	1.62	12.00	.69	1.78
Liquid Food (extract of beef, mutton, and fruits),	86.09	.65	1.21	10.69	1.94	.25

*The sum of insoluble and coagulable proteids, proteoses, and peptones.

MISCELLANEOUS PREPARATIONS (MEAT EXTRACTS, JUICES, AND POWDERS).—(*Continued.*)

CLASS III.

NAME OF PREPARATION.	WATER.	MINERAL MATTER.	ACIDITY AS LACTIC ACID.	TOTAL PROTEIDS.*	INSOLUBLE AND COAGULABLE PROTEIDS.	TOTAL MEAT BASES.
	%	%	%	%	%	%
Maggi's Bouillon,	56.56	21.94	4.10	2.13	.13	5.83
Peptonized Beef, Rose,	45.13	3.52	2.08	22.20	1.38	9.89

CLASS IV.

Beef Extract and Vegetable Tablets,	22.29	23.66	4.76	18.87	10.56	3.15
Leube-Rosenthal's Beef Solution,	72.68	3.91	2.54	16.13	9.88	1.34
Malted Meat Extract of Beef,	8.61	7.87	.84	9.82	7.69	1.40
Beef Peptonoids,	5.72	5.63	.35	23.32	20.19	1.22

UNCLASSIFIED.

NAME OF PREPARATION.	WATER.	MINERAL MATTER.	SALT.	PHOSPHORIC ACID.	CANE SUGAR.	GLYCERIN.
	%	%	%	%	%	%
Carnine Co., Lefranco, Paris, France; Imported by Fougera & Co., Agts., New York,	24.80	.86	.09	.33	47.50	14.2

DIET IN DIABETES.

Nature of the Disease.—There is one disease of quite common occurrence concerning which there is practically a unanimity of opinion among medical men respecting the character of the diet which should be observed by the patient, namely, diabetes. In this disease the metabolism of the system is so changed that the urine contains a greater or less quantity of sugar. The sugar which is found in the urine is not the ordinary one, but is dextrose, the product which arises from the complete inversion of starch by means of an acid. Dextrose also constitutes half of the product produced by inverting cane sugar with an acid or a ferment. Occasionally levulose, a sugar identical with dextrose chemically, but different as to structure (turning the plane of

* The sum of insoluble and coagulable proteids, proteoses, and peptones.

polarized light to the left instead of the right), is found in the urine instead of dextrose. Diabetes is regarded by most diagnosticians as peculiarly a disease of disordered metabolism, more so even than rheumatism or gout. The presence of sugar in the urine is in itself a matter of consequence, inasmuch as it implies a disturbed metabolism, since normal urine does not usually contain even a trace of sugar. Hence the presence of any amount of this substance indicates a very serious disorder of nutrition or disease of the kidneys. In other words, the body has lost the power of oxidizing sugar. Inasmuch as the sugar secreted is dextrose, it has been thought by physicians generally that to control the food in such a way as to diminish the quantity of material capable of forming dextrose would be a rational treatment. A moment's thought will show that the exclusion of food containing dextrose or dextrose-forming material may not at all be a remedy for the disease, although it may offer a probable way of controlling to some extent the principal symptoms by very considerably diminishing the quantity of sugar excreted.

Sources of Sugar.—Von Noorden has noted that sometimes beer-drinking produces sugar in urine, but he was not sure whether it was maltose or grape sugar. He has also noted that there is often an approximately proportional relation between glycosuria on the one hand and decomposition of protein on the other. That sugar can be formed from protein is shown by the following experiment:

(*a*) Three days' diet with much meat and no carbohydrates gave 48.2, 56.7, 57.1 grams of sugar in the urine.

(*b*) Three days with vegetables gave 30.2, 11.9, 2.1 grams.

(*c*) Five days of vegetables with 300 grams of meat per day gave 7.8, 22.8, 33.5, 36.7, 48.3 grams sugar.

(*d*) Two days' diet of vegetables alone gave 8.1 grams and a trace of sugar.

Proteins may yield from 40 to 50 percent of their own weight of glucose.

Those which are made up of amino acids, *e. g.*, casein, are the ones to produce sugar in the body. The transformation into sugar occurs when the organism is in need of carbohydrates. Feeding alanin to a diabetic patient caused a large percentage of sugar to appear in urine. Feeding with casein is accompanied with the most marked degree of glycosuria, legumes (peas, lentils, beans) standing next in this particular, while egg-albumen and the protein of cereals have the least power of producing glycosuria.

In severe cases of diabetes it is suggested to forbid casein and limit the amount of meat to be eaten. There are even a few cases of diabetes in which more sugar is excreted than can be accounted for by the decomposition of carbohydrates and meat, and therefore it is thought probable that the sugar comes from the fat. Since by far the larger part of man's food is of carbohydrate nature, it is difficult to entirely eliminate that class of foods from the diet. The greater the intensity of diabetic disturbance, the greater the amount of carbohydrate that is excreted unused in the urine. Nevertheless nearly all authorities agree that it is advisable in the treatment of diabetes to exclude, in so far as possible, starch and sugar from the diet.

Duering has proposed a "rice" cure. The theory of using this very rich carbohydrate is based on the principle that to limit the diet of carbohydrates to one particular kind is of as much importance as to exclude carbohydrates completely. This idea, however, has not been generally accepted.

In Lusk's "Science of Nutrition" it is stated that sugar must arise from either protein or fat. Pflüger claims that fat metabolism is the principal source of sugar in diabetes. It has also been shown that protein breaks up into amino acids in the intestines, and that such acids when ingested are equivalent in metabolism to protein itself, and may be converted into dextrose.

Cause of Diabetes.—It is not to be inferred that the use of foods containing starch and sugar, from which dextrose is usually formed, is in any sense the cause of the disease. This cannot be the case, because were it so, every individual would suffer from this trouble, since starch and sugar constitute the principal weight of the dry foods of man. Furthermore, Von Noorden shows that whole races, *e. g.*, those in northern climes and also numerous groups of animals, which use hardly any carbohydrates for food, excrete sugar in their urine. These people and animals subsist almost entirely on animal food, and yet sugar is being continually produced and conducted to the tissues. Nevertheless, the common treatment of diabetes is generally accompanied by the administration of a diet in which starch and sugar are excluded as completely as possible. The principal starchy foods are well known, namely, rice, potatoes, and the cereals. The non-starchy foods are represented principally by meat or plant products in which the nitrogenous element is largely developed, such as certain parts of wheat, peas, and beans. But even the wheats which are richest in gluten contain always much larger quantities of starch than they do of nitrogenous elements. If patients crave a sweetened food, levulose may be used, or even saccharin, which, as has been already stated, is not food at all.

Gluten Flour and Gluten Bread.—To increase the quantity of gluten in bread and diminish the amount of starch, for use of diabetic patients, a gluten flour is manufactured, which is produced by washing or removing in some way from ordinary flour a very considerable percentage of its starch. In this way the percentage of the nitrogenous matter is increased, and for practical dietetic purposes in the treatment of diabetes should not be less than 35 or 40 percent.

Standard for Gluten Flour.—The standard for gluten flour has been fixed by the Secretary of Agriculture as follows: "Gluten flour is the clean, sound product made from flour by the removal of starch and contains not less than five and six tenths (5.6) percent of nitrogen and not more than ten (10) percent of moisture."

Many advertisements have been published of gluten flour and gluten bread which are extremely false and misleading. The examination of many samples of so-called gluten flour has shown that the quantity of gluten therein contained was no greater than that of an ordinary rich glutinous wheat. It is evident that the buyer is wholly misled in such cases, and if a gluten bread is really advantageous to a diabetic patient, the benefits expected would certainly not be realized. Examples of the composition of real gluten flour and so-called gluten flour which is nothing more than good rich wheat flour are given in the following tables:

PERCENTAGE COMPOSITION OF TRUE AND OF SO-CALLED GLUTEN FLOURS.

Gluten and Diabetic Flour.

Name.	Water.	Ash.	Protein.	Fat.	Fiber.	Carbohydrates.	Fuel Value per lb.
							Calories.
Gum gluten (Hoyt's),	*11.2	0.96	31.8	1.55	.33	54.15	..
Educator standard gluten flour,	*11.3	.95	26.4	1.67	.37	59.38	..
Gluten flour, 40 percent,	*10.5	0.51	40.25	1.18	0.15	47.42	1732
	† 7.8	1.2	41.1	1.1	..	47.9	
Self-raising gluten flour, 40 percent,	† 8.8	1.3	38.7	1.3	..	50.1	1695
Pure gluten flour,*	† 7.2	.6	78.8	.9	..	12.6	2078
20 per cent. gluten flour,	† 8.9	1.1	21.0	.7	..	68.2	1692
Pure gluten flour, glutosac,	† 8.0	1.1	35.2	.60	..	55.0	1705
Gluten food,	*10.1	.22	85.4	.56	.03	3.69	..
Protosac,	*10.6	.66	36.6	.86	.25	51.03	..
Washed gluten flour,	* 6.2	.80	62.40	.91	.16	29.51	..
Glutosac,	*10.1	1.14	34.06	1.57	.97	52.13	..
Diabetic biscuit flour,	† 7.9	2.04	75.25	8.96	..	5.89	1877
Plasmon meal,	†10.9	7.61	78.65	2.72	..	00	1576
Aleuronat,	‡ 8.5	.89	86.1	.51	..	4.00	..
	10.9	.70	73.65	.24	..	14.55	
Roborat,	‡9.5	1.39	82.2	3.67	..	3.00	..
Wheat protein,	‡8.6	1.10	84.1	1.40	..	4.80	..
Energin from rice,	‡9.1	1.03	83.7	4.54	.27	.67	..
Vegetable gluten,	* 7.9	.65	61.37	1.55	.32	28.23	..
Casoid flour,	*10.0	2.46	85.56	.50	..	00	..
Sanitas nut meal,	* 3.0	2.17	29.00	51.66	2.01	12.13	..
Soy bean meal,	* 7.8	4.4	39.87	19.06	3.85	25.09	..
Almond meal,	* 8.5	6.4	50.62	15.63	2.86	15.90	..
Gluten flour,	*12.7	.43	11.37	.90	.25	74.38	..
Gluten flour,	† 9.2	1.90	15.5	2.6	..	70.8	1714
Diabetic flour,	†10.7	.46	12.0	.46	.25	76.45	1663
Jireh diabetic flour,	* 9.3	1.30	14.3	2.21	1.03	71.95	..
Special diabetic food,	*12.0	1.93	14.25	2.96	1.37	67.47	..
Gluten flour,	§13.0	.55	13.3	1.05	..	72.11	..
Gluten flour,	‖ 8.6	1.29	16.4	3.15	..	70.60	..

It is evident from the analytical data that the last seven products are only common wheat flours.

* Rep't Conn. Agr. Exp't Station, 1906.
† Fetteroff, Examination of Some of the Diabetic Foods of Commerce.
‡ König, page 535. ‖ Blyth, Foods and their Analysis.
§ Bull. 13, Part IX, Bureau of Chemistry, U. S. Dep't Agr.

Gluten Bread.—The separation of starch from flour and the making of bread from the residue was first introduced by Bouchardat in 1841. Many cook books give recipes for making bread from flour of this kind. The gluten flour may be prepared in the home, and it is, as a rule, much safer to prepare it in this way than to buy it on the market, because it can be used in the moist state as soon as made. The starch can be washed from wheat flour by a simple process of kneading, using pure cold water for a wash. After the dough is made it is worked with the fingers, or with proper machinery, and water added from time to time, thus washing out the starch. It is better to do the kneading in a vessel the bottom of which consists of a fine gauze which will permit the particles of starch to pass through but will retain the gluten. The washing may be continued until the wash water ceases to be white and practically all the starch is removed. The residual dough can then be baked into bread. Usually, however, gluten flour is not entirely free from starch, and perhaps it is not advisable, for the reason which has already been stated, namely, that starch is a normal constituent of the food and its complete withdrawal produces an abnormal state of nutrition which may do more damage than a small amount of starch. There is a simple test for the presence of starch in a gluten flour known as the iodin reaction, and due to the fact that a solution of iodin mixed with a starch produces a deep blue color. This is an extremely delicate test, however, so that a very small amount of starch might appear to be very large when tested with this reaction alone.

Instead of using the gluten obtained from wheat flour, other albuminous substitutes have been proposed, such as the soy bean, almonds, cocoanuts, and Iceland moss. Experience has shown, however, that patients soon tire of bread made from gluten flour or any of its substitutes. Many physicians have therefore given up its use altogether, prescribing a standard diet free from carbohydrates, and allowing a small amount of good ordinary bread, which is much more palatable and of which the patient does not tire. It is usually advised that the bread be well toasted. Some physicians, instead of prescribing the white bread, use the various forms of Graham bread or brown bread, made from either the whole grain or that from which only a portion of the bran has been removed.

Impracticability of Securing a Diet Entirely Free from Starch and Sugar.—It would be practically impossible to secure for man a diet entirely free from starch and sugar. Even lean meats contain sometimes as much as 1 percent of a sugar-producing substance, and the best of the gluten flours and gluten breads contain very notable quantities of starch. Soy beans, when ripe, are supposed to contain no starch, and would prove a valuable food for diabetics if sugar were not formed from their protein. Most of the nuts are also very low in carbohydrates, as shown in the following table:

PERCENTAGE COMPOSITION OF NUTS.*

Kind of Nut.	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Fuel Value per Pound.
				Starch and Sugar.	Fiber.		
							Calories.
Butternut,	4.5	27.9	61.2	3.4		3.0	3370
Brazil nut,	4.7	17.4	65.0	5.7	3.9	3.3	3120
Pecan,	3.4	12.1	70.7	8.5	3.7	1.6	3300
Hickory,	3.7	15.4	67.4	11.4		2.1	3345
Filbert,	5.4	16.5	64.0	11.7		2.4	3100
Cocoanut,	13.0	6.6	56.2	13.7	8.9	1.6	2805
Almonds,	4.9	21.4	54.4	13.8	3.0	2.5	2895
Pistachio,	4.2	22.6	54.5	15.6		3.1	3250
Walnut,	3.4	18.2	60.7	13.7	2.3	1.7	3075
Chestnut,	43.4	6.4	6.0	41.3	1.5	1.4	1140

The chestnut contains considerable amounts of starch, and is therefore not adapted for this purpose. Peas and beans also contain large quantities of starchy matter, and various vegetables, which contain little starch, are found to carry a considerable percentage of sugar. It is impracticable, therefore, and perhaps undesirable, to secure a diet for diabetic subjects which is entirely devoid of sugar and starch, for it is the total carbohydrates which must be considered and not wholly the starch. Moreover, an extraordinary change in the character of the diet, which would be represented by a nonsugar-non-starch ration, would probably be of more injury to the digestive system by far, even of a diabetic patient, than a ration containing a normal amount of these substances. For this reason it is not only impracticable, but also undesirable, to secure a ration which is devoid of the sugars and starches.

Professor Osborne, of Yale Medical School, says: "I have not a doubt that many a patient with diabetes mellitus has been hurried to his grave by rigid starch-free diets. I also believe that the fact that most so-called starch-free gluten foods contain starch has allowed many a diabetic to live months longer than a starch-free diet would have allowed. An absolute withdrawal of carbohydrates from the food of patients having true diabetes mellitus will always increase the acetone and diacetic acid, and often the ammonia and β-oxybutyric acid, and toxic acidemia and coma become imminent. Hence, it is unjustifiable, sugar having become discovered in the urine, to withdraw the starches absolutely or too rapidly from the diet."

Test Diet for Determining Toleration of Carbohydrates.—In Osler's "Practice of Medicine" † attention is called to the fact that in the case of a diabetic patient the first duty of the physician is to ascertain the capacity for tolerating carbohydrates, meaning thereby particularly sugar and starch. This should be determined by placing the subject for at least five days on a diet

* Jaffa, Farmers' Bulletins Nos. 28 and 332, U. S. Department of Agriculture.

† Reprinted from Osler's The Principles and Practice of Medicine, copyright, 1909, by D. Appleton & Co.

from which starch and sugar are rigidly excluded, that is, a diet consisting exclusively of protein and fat. The quantity of food given, in case it can be tolerated, should be a generous one, that is, approximately 40 calories for each kilogram of body-weight. A diet based on the recommendations of Von Noorden which would secure the desired result is as follows:

Breakfast: 7.30 A.M. 150 grams of beefsteak or mutton-chops without bone; two boiled or poached eggs; 200 c.c. of tea or coffee.

Lunch: 12:30 P.M. 200 grams cold roast-beef, mutton, or chicken; 60 grams celery, fresh cucumbers, or tomatoes, with 5 c.c. vinegar, 10 c.c. oil, pepper and salt to taste; 20 c.c. whisky (if desired); 400 c.c. of water or Apollinaris water; 60 c.c. coffee.

Dinner: 6 P.M. 200 c.c. clear bouillon; 200 grams roast beef; 60 grams lettuce with 10 c.c. vinegar; 20 c.c. olive oil, or three tablespoonfuls of some well-cooked green vegetable, as spinach; three sardines à l'huile; 20 c.c. cognac or whisky (if desired), with 400 c.c. Apollinaris water.

Supper: 9 P.M. Two eggs, raw or cooked; 400 c.c. Apollinaris or Seltzer water.

It is further advised that "with the four meals at least 15 grams of butter should be used in making the gravies and with the eggs. No milk or sugar is permitted with the tea or coffee, but saccharin may be used to sweeten them. The time of taking lunch and dinner, of course, may be reversed. This daily diet should provide a person of 60 kilos (132 pounds) with a little over the requisite 2400 calories for an individual of that weight. One precaution must be emphasized here. If the patient has been eating freely of starches, these must be cut down slowly for two or three days before he is placed on the standard diet. Any sudden and radical change from one diet to another is liable to induce coma. As it has been found that a dog must fast five days before the glycogen of his liver has been all used up, it is well to keep the diabetic on the above diet for at least five days; by so doing it practically eliminates the possibility that any sugar excretion at the end of that time is derived from the stored-up glycogen of the liver."

Inasmuch as a diet entirely free of starch and sugar is not a normal diet, and hence should only be used in case of necessity, it is advisable to find out how much carbohydrate a diabetic patient can tolerate without unduly increasing the quantity of sugar in the urine. For this purpose, after the treatment above mentioned, small quantities of bread, preferably bread made from white flour, may be used. A well baked loaf of white bread contains approximately 55 percent of starch. Only 25 grams should be given for the first few days, and if the sugar does not reappear in the urine, or is not increased in quantity, another 25 grams may be added, and so on until the symptoms of glycosuria develop. The degree of tolerance, therefore, may be expressed in the form of a formula as follows: Tolerance equals standard diet plus x grams of starch,

x representing the number of grams of starch the patient can take as determined experimentally, without sugar appearing in the urine.

Dietaries Recommended by Von Noorden.—Von Noorden, one of the most eminent authorities on diabetes, in his work entitled "Disorders of Metabolism and Nutrition,"* divides foods intended for diabetic patients into two classes: (1) Those food products which are practically free from carbohydrates, and which should form the base of the daily diet. (2) Certain accessory articles of diet which include substances containing more or less carbohydrates. The use of these accessory articles is based on the fact that it is necessary not only to prescribe a diet which has some specific relation to the disturbance, but which will also conserve, or tend to conserve, the general health. As carbohydrates are such an important part of a normal diet, it is not a safe plan to continue too long a diet from which they are entirely excluded.

Standard Test Diet.—The standard test diet is prescribed by Von Noorden as follows:

Breakfast: 200 grams coffee or tea with one to two tablespoonfuls of thick cream. 100 grams of hot or cold meat (weighed after cooking). Butter. Two eggs, with bacon. 50 grams of white bread.

Lunch: Two eggs cooked as desired, but without flour, or any other hors d'œuvre free from flour. Meat (boiled or roasted), fish, venison, or fowl, according to taste, about 200 to 250 grams altogether (weighed when cooked). Vegetables, such as spinach, cabbage, cauliflower, or asparagus; prepared with broth, butter, or other fat, eggs or thick sour cream, but without any flour. 20 to 25 grams creamy cheese (such as Camembert, Brie, etc.); plenty of butter. Two glasses of light white or red wine, if desired. One small cup of coffee, with one to two tablespoonfuls of thick cream. 50 grams of white bread.

Dinner: Clear meat soup, with egg or green vegetable in it. One to two meat dishes, as at lunch. Vegetable dishes, as at lunch. Salad of lettuce, cucumber, or tomatoes. Wine. No bread. Drinks during the day (exclusive of wine), one to two bottles of aërated water.

This test diet is intended to reduce the sugar excretion to a minimum and is preliminary to a more generous diet in which bread is included if the sugar excretion is not too greatly increased.

Oatmeal as a Diabetic Food.—Von Noorden has recommended as a food for diabetic patients in certain cases oatmeal, or rather a gruel made from oatmeal. The use of this substance was the result of an accidental observation. A number of patients, in addition to diabetes, were suffering with severe disturbances of the stomach and the lower intestine. For this trouble they were confined to a diet consisting exclusively of oatmeal gruel. The observations in these cases showed that the amount of sugar in the urine was diminished during the continuance of this diet. The oatmeal, of course, is not used alone; as prescribed by Von Noorden, it consists in the daily administration of from 200 to 250 grams of oatmeal, best given in the form of gruel,

* Published by E. B. Treat & Co., New York.

every two hours. In addition to this, 200 to 300 grams of butter are prescribed, and about 100 grams of a vegetable proteid, or for this a few eggs may be substituted. No other food is allowed except black coffee or tea, lemon juice, good old wine, or a little brandy or whisky. This diet has not been found entirely satisfactory by many other authorities, nor does Von Noorden urge it for all cases. The oatmeal, of course, contains considerable quantities of starch, but it is starch of an entirely different kind from that of wheat or rye, the usual bread diet of civilized nations. The inference is that the starch of the oatmeal does not act so injuriously as that of wheat or rye. Von Noorden makes the following statement in regard to the oatmeal diet: "Unfortunately, however, there are only relatively few cases in which the result is quite so surprisingly beneficial; in many others it is incomplete, although still satisfactory; in others, again, no result at all is obtained." The best results were found in very severe cases when there was a large excess of sugar in the urine. On the other hand, the treatment was almost always a failure where only a slight amount of sugar was found in the urine.

Other starchy foods which have been recommended are the potato and rice, each having its protagonist among reputable authorities, based upon the supposition that both the potato starch and the rice starch are far less injurious than rye starch or the wheat starch found in ordinary breads.

Water and Other Beverages.—It is the general consensus of opinion that it is injurious to restrict the quantity of water which a diabetic patient is allowed to use. The fact that the drinking of a considerable amount of water increases the volume of the urine is perhaps a favorable, rather than an unfavorable, symptom. Thirst is a very common symptom in diabetes, and it should be allayed by plenty of pure water. Many physicians recommend mineral, or bottled, waters. An occasional change from a pure spring-water to a bottled water may be advisable, but on account of the cost, which is often a matter of importance, it may be said that pure spring-water, as fresh as can be had, will serve all purposes. Lemonade may also be used, but if a sweet taste is craved it must be produced by the addition of saccharin and not by sugar. It is better by far to ignore the craving for sweets than to gratify it with such a questionable substance as so-called "saccharin."

Osler recommends the use of whisky, brandy, and rum on the ground that it aids in the digestion of fat and tends to make up for the loss in heat-units resulting from the cutting off of carbohydrates.

Use of the Soy Bean.—Dr. Julius Friedenwald and Dr. Ruhräh, in the Proceedings of the One Hundred and Twelfth Annual Meeting of the Medical and Chirurgical Faculty of Maryland, held at Baltimore on April 26, 1910, recommend the soy bean also as a diet in diabetes. Eight cases of diabetes were treated with this food, and the conclusions which were reached were as follows:

1. The soy bean is a valuable addition to the dietary of the diabetic on account of its palatability and the numerous ways in which it can be prepared.

2. The soy bean in some ways causes a reduction in percentage and total quantity of sugar passed in diabetic subjects on the usual dietary restrictions.

The following recipes for broths and muffins made from the soy bean are of interest in this connection:

Broths.—Add from 1 to 8 ounces of the flour to one quart of beef, mutton, veal, or chicken broth and boil for fifteen minutes, adding water to make up for loss by evaporation; or, boil the same quantity of the soy flour for one-half hour with one quart of water, to which has been added a piece of ham, bacon, or salt pork to give flavor. Each ounce of the flour will add to the broth about 13 grams of protein and 120 calories, or, in percentages, add 1.4 percent protein, 0.60 percent fat, and 0.30 percent carbohydrates. A broth made with 6 ounces of the soy flour to the quart would be half as rich in protein and fat as steak.

Muffins.—To make muffins from the soy flour, take 1¼ teacupfuls of the soy flour, ¼ teacupful of wheat flour, ½ teaspoonful of salt, 2 eggs, 1 teacupful of sweet milk, 2 rounded teaspoonfuls of baking powder, and 1½ tablespoonfuls of melted but not hot butter. Beat well together, adding the melted butter last, and bake in gem pans in a hot oven. This will make about 12 muffins, which will contain about 150 grams of protein and which will yield about 1800 calories, of which the carbohydrates produce but 280.

Foreign Diabetic Foods.—Tatterolf has collected a number of foreign diabetic foods, the composition of which is shown in the subjoined table.

COMPOSITION OF FOREIGN DIABETIC FOODS.

Material.	Water.	Ash.	Ether Extract (Fat).	Protein (Nitrogen × 6.25).	Carbohydrates Including Fiber (by Difference).	Fuel Value per Pound (Calculated).
	%	%	%	%	%	Calories.
Casoid flour,	10.25	2.50	1.61	82.50	3.14	1661
Casoid dinner rolls,	6.95	1.84	11.08	78.00	2.13	1918
Casoid biscuit, No. 1 (plain),	7.20	2.53	16.78	64.75	8.74	2075
Casoid biscuit, No. 2,	7.48	3.59	25.51	57.81	5.61	2256
Casoid biscuit, No. 3,	7.90	4.95	25.02	54.31	7.82	2211
Casoid rusks,	5.42	4.47	32.33	36.98	20.80	2439
Casoid lunch biscuit,	4.20	3.77	44.87	25.53	21.63	2771
Prolactic biscuit,	6.34	3.95	27.51	42.91	19.29	2317
Kalari biscuit,	6.31	3.70	31.43	56.88	1.68	2400
Kalari batons,	8.13	4.40	33.70	52.88	0.89	2422
Almond biscuit (plain),	3.66	3.20	28.02	28.34	36.78	2394
Almond short breads,	4.20	3.51	52.11	19.54	20.64	2946
Ginger biscuit + saccharin (trace),	2.45	3.69	58.62	17.06	18.18	3129
Cocoanut biscuit + saccharin (trace),	2.63	3.13	61.28	16.61	16.35	3199
Gluten bread (French),	7.78	1.29	2.36	35.94	52.63	1747
Conalbin-Mehl No. 1 (diabetic flour),	9.42	0.52	0.39	10.88	78.79	1684

The casoid preparations, it is claimed, are made from milk, vegetable albumin, and eggs. They contain only small quantities of carbohydrates. Many of the products, it is seen from the table, contain such large quantities of carbohydrates as to render them, theoretically at least, undesirable for diabetic patients.

DIET IN NEPHRITIS.

Importance of Diet.—The various forms of inflammation of the kidney are designated by the general term nephritis. The diet in the case of nephritis is almost as important as in the case of diabetes. Von Noorden is particularly insistent that foods which tend to produce increasing quantities of hippuric acid in the urine should be excluded in all cases of nephritis. He says:

> Hippuric acid, as is well known, is generated from benzoic acid and glycocol by a synthetic process in the kidneys themselves. In nephritis, particularly in the more acute forms, this synthesis is rendered more difficult, so that a proportionately large part of the benzoic acid that is ingested, or that is formed within the body and enters the blood, leaves the kidneys unchanged, or in the form of a salt. The other component, glycocol, under these circumstances is also in small part excreted unchanged. The greater proportion that under normal circumstances would have been converted into hippuric acid, is converted into urea, and is excreted as such. While it is not known that the excretion of benzoic acid is a particularly difficult task when the kidneys are diseased, or that benzoic acid can directly damage the kidneys, we should nevertheless, from the standpoint of protective therapy, prevent the entrance of benzoic acid into the blood-stream circulating through the diseased kidneys, for when we overload the blood with benzoic acid we impose a task on the sick kidneys that they are not capable of performing. We can easily avoid this irritation and this stimulation of the organ if we regulate the diet in such a manner that as little benzoic acid as possible circulates in the blood. From this point of view green vegetables, fruit containing kernels, and cranberries that contain large quantities of benzoic esters, should not be permitted in acute inflammation of the kidneys. In such fruit as pears and apples, and in many berries (particularly raspberries and grapes), on the other hand, we find traces only of benzoic acid; those fruits, therefore, and syrups made from them, constitute an excellent addition to the diet of nephritic cases, for they are borne very well, they stimulate digestive processes, and offer some variety.

DIET IN OBESITY.

General Discussion.—It should be understood that obesity is not a disease or a disturbance of the digestive system. It is rather a disturbance of the general metabolism in which the fats formed from the food consumed are not properly oxidized or burned in the tissues, but are deposited as such. The disease which causes obesity may, however, originate in the over-stimulation of the digestive organs through excessive eating. In many instances this over-stimulation does not result in the taking on of an undue amount of fat, while in others the fat-forming habit develops as any other disease would develop in similar circumstances.

A diet which is properly consumed and expended by one individual, and which would keep that person in a lean condition, would in another produce the opposite effect, namely, obesity, which tendency may be transmitted by heredity, and might be characterized as an inborn error of metabolism.

The capacity of the body to utilize food materials in its economy differs in each individual, depending on numerous factors (worry, excitement, climate, occupation, habits, etc.). When food is supplied in excess of this capacity, it is stored in the body chiefly as fat.

The literature on patent and secret remedies is full of so-called cures for excessive fat. I do not believe that any of these claims are founded on a scientific basis. If the patient loses in weight under the influence of these drugs, it is due to a disturbance of the digestion caused by the action of the drug.

Hare's Dietary.—Hare, in his work on "Practical Therapeutics,"* recommends the following dietary in cases of obesity:

The food of the patient suffering from obesity is to be cut down gradually, and the character of it arranged so that, though its bulk be great, its nutritive properties are small. Beef and other meats are concentrated foods containing much nourishment in a small bulk, while lettuce, spinach, cabbage, and nearly all vegetables, except roots or tubers, contain a large amount of fiber useless to the body. By the use of a carefully arranged vegetable diet in obesity we cut down the actual amount of food absorbed, and by its bulk keep the stomach so busy at sifting the nutritious from the non-nutritious materials that hunger is not felt, because another meal-time is reached almost before the food of the first is assimilated. We find, therefore, that the diet for the reduction of corpulence should consist chiefly of bulky vegetables, but not too exclusively of any one article or set of articles. Heretofore it has been thought that proteids (meats, eggs, etc.) should be used to take the place of all hydrocarbons, or carbohydrates (fats, starches, and sugars), but this is not physiologically correct, as both forms of food are always needed for health, and it has been found that proteids may be converted into fats in the body. The following bill of fare will be found of service in the treatment of obesity.

Breakfast: One or two cups of coffee or tea, without milk or sugar, but sweetened with a fraction of a grain of saccharin. Three ounces of toasted or ordinary white bread or 6 ounces of bran bread. Enough butter may be used to make the bread palatable—not more than one ounce. Sliced raw tomatoes with vinegar or cooked tomatoes without any sugar or fats. This diet may be varied by the use of salted or fresh fish either at breakfast or at dinner. This fish must not be rich like salmon or sword-fish, but rather like perch or other small fish.

Noon meal (dinner): One soup-plate of bouillon, consommé, Julienne, or other thin soup, or Mosquera's beef-jelly, followed by one piece of the white meat of any form of fowl or a small bird. Sometimes a small piece, the size of one's hand, of rare beef or mutton, but no fat, may be allowed, and this

* Published by Lea & Febiger, Philadelphia.

should be accompanied by string-beans, celery (stewed or raw), spinach, kale, cabbage, beans, asparagus, leeks, and young onions. Following this, lettuce with vinegar and a little olive oil (to make a French dressing), a cup of black coffee or one of tea, and a little acid fruit, such as sour grapes, tamarinds, and sour oranges or lemons, may be taken, and followed by a cigar or cigarette.

Supper should consist of one or two soft-boiled eggs, which may also be poached, but not fried, a few ounces of bran bread, some salad and fruit, and perhaps a glass or two of light, dry (not sweet) wine, if the patient is accustomed to its use.

Before going to bed, to avoid discomfort from a sensation of hunger during the night, the patient may take a meal of panada, or he may soak Graham or bran crackers or biscuits in water and flavor the mass with salt and pepper.

The reduction of diet is generally best accomplished slowly, and should be accompanied by measures devoted to the utilization of the fat present for the support of the body. Thus the patient should not be too heavily clad, either day or night, should resort to exercise, daily becoming more severe, and should not drink freely of water, unless sweating is established sufficiently freely to prevent the accumulation of liquid in vessels and tissues."

Fats in the Diet for Obesity.—The fats of the food are more readily oxidized and are a more immediate source of energy than carbohydrates and proteins, both of which are sources of fats in the body. I believe, in spite of this capacity for utilizing energy which is readily supplied by fats, that it would be harder to retard the development of corpulency if the diet contained a great amount of this constituent. Therefore, fats as well as carbohydrates should be excluded as far as possible from the diet in cases of obesity.

Effect of Sugars and Starches.—It is generally held among physiologists that the sugars and starches are more disposed to produce corpulency than the fats, and lean meats, and vegetables poor in sugar and starch. In selecting a diet to correct overweight, it is advisable to exclude therefrom all bodies which are excessively rich in starch and sugar. It is manifestly impossible and undesirable, under ordinary circumstances, to secure a diet in which neither sugar nor starch is found; but it is possible to so modify a diet that it may contain less starch and sugar, and be richer in nitrogenous matters, such as are represented by peas, beans, lean meats, etc.

Quantity of Food.—Having so modified the diet the next step is to limit it to the smallest quantity that will preserve health. The best remedy for obesity is hunger, but the use of this remedy requires great force of will and strength of character, so that it is not easy to secure volunteers for this kind of treatment. If the patient is really in earnest about reducing his weight, and every one who is overweight should be, there is no method which can be recommended, not injurious to health, that is so effective as the limitation of the diet. Having chosen a diet poor in starch and sugar, it should be limited to a small number of calories per day, not exceeding, for the average man, 2000 to 2500.

Utility of Exercise.—A very efficient method of aiding in the reduction of weight, as noted in Hare's dietary, is by judicious exercise. It has been urged as an objection to exercise that this itself increases the desire for food. Of this there is no question, but we are assuming in this instance that the patient has will power enough to limit his food to the small quantities mentioned. If this be the case, the conjunction of proper exercise with a limited diet will hasten the cure. I have nothing to say here respecting the character of the exercise, except that it should be such as to bring into action as many muscles of the body as possible, but not be too violent nor too long continued. Exercise increases the katabolic activities of the body; in other words, it implies the consumption of a greater amount of heat and energy. This heat and energy must either come from the food itself, or from the tissues of the body. The object of the exercise, conjoined with the limited diet, is to oxidize and thus remove the excessive quantities of tissue.

Gradual Loss of Weight.—Attention should be called, of course, to the danger of extreme depletion. The limitation of the diet and the vigor of the exercise should not be carried to such an extreme as to actually induce the perils of starvation. In all cases it is better to lose flesh slowly than suddenly. A gradual loss of overweight will leave the body still in excellent condition, with all the organs gradually becoming accustomed to the diminishing weight. The result will be that when the normal weight is finally reached, all the organs of the body will be in a healthy state, the appetite will be under control, and the patient will be able to maintain the condition of equilibrium. This will assist in preventing a recurrence of the deposition of fat, which otherwise will readily take place if the diet be again increased and the exercise diminished. The normal weight for a man six feet high may be assumed as 190 to 200 pounds, and the body will be more effective for both mental and physical work if it is not saddled with a handicap of excessive fat. The most important point, aside from the general directions given, is to avoid the antifat nostrums and the theories of unscientific enthusiasts. We are already a nation largely addicted to the taking of drugs, and the amazing virtues of remedies for all physical and mental ills are heralded by one's friends and by advertisements *ad finitum.* As before stated, these remedies rarely, if ever, are efficacious in reducing weight and they may be harmful.

DIET IN TUBERCULOSIS.

Nature of the Disease and Importance of Diet.—Tuberculosis is a disease which in its most common form attacks the tissues of the lungs, but there is scarcely any part of the body, not even the bones, that is exempt from its ravages. Modern investigations have placed it among the infectious diseases, the specific cause of the disease being the tubercular bacillus, which is introduced into the system through either the lungs or the digestive organs. The vigorous and well-nourished body is able to withstand an infection of this kind and to destroy the infecting germ before it succeeds in effecting lodgment. If, on the contrary, the infecting organism is introduced into a system of low vitality and small resistance, it finds an easy lodgment and develops rapidly. In all cases of tuberculosis one of the first symptoms, after the disease has become established, is the progressive loss of weight, due to disturbed metabolism or inability to digest or assimilate food products. Accompanying the loss of weight there is nearly always a distinct rise of temperature amounting to as much as 2 degrees during the day, in the early stages of the disease, and returning to normal by morning. Hence the "hectic flush" often observed in the case of consumptives. The daily rise of temperature is an important index as regards both diagnosis and treatment.

Exercise is strictly controlled in certain sanitoria. Sometimes when the patient is first admitted he is put to bed or compelled to sit absolutely quiet the whole time. Later he is allowed a prescribed number of turns on the porch, and the amount of exercise is gradually increased or decreased, and the diet modified as the indices of improvement, namely, weight and temperature, change for better or worse.

It has for many years been one of the most important studies of the medical fraternity to establish a system of diet in tuberculosis which would add additional power to the system for overcoming, through its own efforts, the ravages of the disease, localizing the infection to particular tissues, and preventing its spread. While it is probably impossible to effect a complete cure of tuberculosis unless treatment is begun in its earliest stages, it is undoubtedly possible to check its advance and so nourish and support the system as to prolong life for an indefinite period. Among the sanitary aids which are employed for this purpose living in the open air and a proper diet are the most important.

Differing Opinions as to Character and Amount of Food.—The greatest difference of opinion is found among the medical fraternity in regard to the diet to be recommended. In some instances a strictly vegetable diet has been prescribed, and in others an exclusive meat diet. Milk, and also milk and eggs, have been highly recommended. Formerly, alcohol was supposed to be a means of limiting or restricting the disease, but this view is no longer held by most competent authorities on the subject. A deficiency of lime in the food has also been mentioned as a possible factor in causing tuberculosis.

Lately a theory of treatment has gained much vogue which is based on the overfeeding idea. The principle involved is that if the appetite alone be consulted, the patient will not eat a sufficient amount of nourishing food to secure the desired result. As long, therefore, as the digestive organs remain capable of discharging their functions, the utilization of the extra energy of these organs has been applied to a restoration of a state of health in the diseased organs. Very good results have been secured in many cases by overfeeding, that is, by forced feeding, so to speak, the patient being required to swallow more food than his appetite demands. Naturally, the foods selected for this purpose are those which are most digestible and best suited to secure the end in view. Milk, eggs, bread, fruit juices, sour milk, fermented milk, meats of healthy animals, butter and other edible fats, including oils, have all been recommended to a greater or less extent.

Forced Feeding in Normal Individuals.—It is of interest to compare the effects of forced feeding on individuals in normal health with those of similar methods in cases of impaired metabolism, a condition which usually attends tuberculosis. English scientists connected with the Brompton Hospital have made a study of the effects of forced feeding on normal individuals, and the following results are recorded by Bardswell, Goodbody, and Chapman, in the "Journal of Physiology" for 1902:

1. A marked increase in the amount of nitrogen excreted.
2. A diminution in the absorption of fat.
3. No diminution in the absorption of nitrogen.
4. A rapid and large gain in weight, which was in every case associated with marked impairment of general health. The chief symptoms resulting from the overfeeding were loss of appetite, nausea, dyspepsia, drowsiness, abdominal discomfort, and diarrhea.
5. The weight gained was rapidly lost on return to ordinary feeding.

Results of Experiments on Tubercular Patients.—Many investigations have been made in England respecting the effect of diet on tuberculosis, both as a means of amelioration and arrest. Important studies have been carried out at the Brompton Hospital of diets of different types and magnitudes. The typical diets employed are shown in the following tabular statement:

ORDINARY DIET.

(Per Day. P. = Protein; F. = Fat; C. H. = Carbohydrates.)

Milk (pints),	3
Cooked meat, oz.	3
Cooked bacon, "	1
Butter, "	1
Bread, "	8
Sugar, "	1
Cooked vegetables, "	4
Rice pudding, "	5

Nutritive value (approximately):

P.	F.	C. H.	Cals.
115	121	240	2590

MODERATELY LARGE DIET.

Milk (pints),		4
Bread,	oz.	6
Cooked meat,	"	7
Cooked vegetables,	"	4
Butter,	"	2
Cooked egg,	"	1
Cooked bacon,	"	1.5
Sugar,	"	2
Rice pudding,	"	5
Grapes,	"	4

Nutritive value (approximately):

P.	F.	C. H.	Cals.
160	179	271	3442

VERY LARGE DIET.

Milk (pints),		5
Cooked chicken,	oz.	4
Cooked bacon,	"	2
Eggs,	"	2
Butter,	"	2½
Bread,	"	11
Sugar,	"	3
Rice pudding,	"	5
Cooked vegetables,	"	6
Fruit (grapes and figs),	"	8
Somatose,	"	3
Lactose,	"	1

Nutritive value (approximately):

P.	F.	C. H.	Cals.
271	231	390	5026

The conclusions which were drawn from the experiments in the Brompton Hospital are as follows:

1. The patients made very satisfactory progress both clinically and experimentally when the ordinary diets first prescribed to them were somewhat increased; in short, when treated with moderately large diets.

2. These comparatively large diets were especially well borne by patients much below their weights. They did not give such satisfactory results in patients up to weight and with arrested disease. The patients made much less satisfactory all-around progress on the very large diets than on the diets of considerably smaller nutritive value.

3. Weight was gained in nearly every case, in some to a very large extent and very rapidly, but this gain of body-weight was not associated with any more satisfactory progress in the tubercular lesion than was obtained with the smaller diets; on the other hand, general health suffered considerably, as indicated by failure of appetite, marked digestive and intestinal derangements, and in one case vomiting.

4. In spite of the fact that the clinical conditions of the patients observed were widely different, and that the digestive system in at least two of the patients was obviously impaired, the digestion and absorption of both nitrogen and fat were uniformly good. This was so even in the case of patients with high fever. The absorption of fats was excellent, although very large quan-

tities were sometimes given; *e. g.*, with an intake of 231.3 grams, 96.4 percent was absorbed.

5. It was noticeable that the patients complained least of digestive discomfort on the diets that gave the best results experimentally.

6. With regard to the nitrogen: When the amount of proteid in the diet was much increased, it resulted in:

(*a*) An increased excretion of nitrogen out of all proportion to the increased amount retained in the body.

(*b*) A diminution in the percentage of nitrogen excreted as urea, and consequently an increase in the percentage amount excreted in a less oxidized form, indicating diminished nitrogen elaboration.

(*c*) Diminution in the percentage of nitrogen absorbed.

(*d*) An increase in the amount of aromatic sulphates excreted, indicating increased intestinal putrefaction.

Economy of Feeding.—It is evident that if cheaper foods are found to be just as nutritious and just as efficacious in cases of tuberculosis and other diseases, it is highly important, for the sake of the poor, that the prescribed diet should cost as little as possible. In view of the fact that meat is the most expensive article of diet, studies have been made of meat-free diets and meat-rich diets, both as to efficiency and as therapeutic agents, and also as regards comparative merit of nutrition. The general results of these investigations show that there is much to be said on both sides. The weight of medical opinion, however, inclines to the opinion that a diet reasonably rich in meat is to be generally preferred. In such matters the same instructions should govern as those relating to the removal of the patient to a different locality. As is well known, one of the most frequent remedial agents suggested to the patient is a change of climate, and also, incidentally, a change of surroundings, of friends, and of physicians. Such advice may be valuable to those who are able to follow it, but in very many cases it is utterly impossible, for financial reasons, for the patient to be removed to a different locality. Often very good results are obtained by changing one's habits of life, sleeping out of doors, etc., without leaving one's home. In the same way, when the patient can afford it, the best possible diet, irrespective of its cost, should be provided. But if this is not practicable, the very best diet within reach of his means should be secured, and a practically meat-free diet may yield very satisfactory results at much less cost.

Advantages and Disadvantages of a Meat-free Diet.—Comparative statistics have been compiled by English scientists on the economy of different methods of feeding in cases of tuberculosis, and the advantages and disadvantages of each.

The advantages of a meat-free diet observed by the English authorities are as follows: "The great advantage of a meat-free diet is its small cost. For example: The meat-free diet taken by patient 1, which had a nutritive value of proteid 175, fat 146, carbohydrate 550, cost 27.5 cents a day. If all the proteid given in the form of pulse in this diet had been replaced by proteid in the shape of meat, the cost of the diet would have been increased to 42.5 cents a day, an extra cost of 55 percent."

The same authorities have studied particularly the disadvantages of a meat-free diet, and their conclusions are as follows:

There are certain serious disadvantages in an entirely meat-free diet. In the first place, a diet such as we used, namely, one in which the proteid is given chiefly in the form of pulse, is, of necessity, of a bulky character.

The large bulk of these meat-free diets, as compared with a diet containing a similar amount of proteid from animal sources, is due to the fact that although uncooked meat and pulses have approximately the same proteid value, meat, in the process of cooking, loses water, whereas the pulses, by the time they are fit for eating, have taken up water to the extent of twice their own weight. For example, a sirloin contains in its uncooked condition roughly 20 percent of proteid, but when cooked, owing to the loss of water, its proteid value rises to 28 percent. On the other hand, the average percentage composition of pulses, as regards proteid, is about 23 percent in the uncooked condition, but after the absorption of water during cooking, the percentage composition only amounts to a little over 8. To secure any given amount of proteid, a bulk of vegetable food is required some four times as great as would be necessary if animal food were used. This fact is a great practical obstacle to the more general use of vegetable proteid in dietaries for consumptives. It is sometimes found a difficult matter to get patients with normal appetites and digestions to take a sufficiently large diet when the pulses are relied upon as the source of proteid. This difficulty experienced in the case of patients with good appetites, etc., becomes a matter of impossibility when dealing with patients with marked anorexia.

Another disadvantage of these meat-free diets is the difficulty of making them sufficiently appetizing. To make a diet of pulses really palatable requires considerable skill in cooking, a skill which the average working-class housewife does not possess. Unless handled and varied with considerable care, a diet made up largely of pulses is somewhat insipid, and lacks the flavor and variety of the ordinary meat diet. Further, prejudice and custom, especially amongst the lower classes, are opposed to the adoption of a largely vegetable diet, but the feeling in favor of a meat diet is perhaps not so strong as it used to be.

Another objection to the use of a large quantity of pulses in a diet is the relatively low proportion of it which is absorbed in the alimentary canal as compared with the proportion of meat which is absorbed.

We were unfortunately unable to ascertain the exact amounts of the pulses absorbed in the case of our patients, but such evidence as we possess, viz., the gain in weight, which was rapid, the fact that the amount of nitrogen in the urine did not decrease compared with its excretion on an ordinary mixed diet, and the excellent clinical results obtained, indicate that at all events intestinal absorption was quite satisfactory.

Metabolic observations of a somewhat limited nature showed that in the case of patients with normal alimentary canals, these large meat-free diets did not give rise to any intestinal troubles; for instance, regular observation showed that at no time was there increased intestinal putrefaction.

To summarize, then, the results of our observations show that—

1. Vegetable proteid, as the main source of the daily intake of proteid in a diet for the tuberculous, is thoroughly satisfactory so long as a sufficient amount of it is taken.

2. The clinical results obtained, when treating consumptives upon meat-free diets of an adequate nutritive value, are often quite as good as the results that are obtained when ordinary meat diets of similar nutritive value are used.

3. Owing to the bulky nature of a meat-free diet, its use is restricted to patients with normal, or approximately normal, appetites and digestions, and is unsuitable for the treatment of those with marked impairment of the alimentary tract.

4. The use of vegetable proteid in the place of all the meat usually prescribed in an ordinary meat diet effects an economy of some 33 percent.

5. When economy is an object, the necessary proteid in a dietary should be given at least in part in the form of vegetable proteid. In the case of individuals with normal appetites and digestions, the meat of an ordinary mixed diet can be altogether replaced by pulses, but such an entirely meat-free diet is, on several grounds, not entirely satisfactory, and should not be used unless very strict economy is essential.

Views of the Illinois State Board of Health.—The following suggestions made by the Illinois State Board of Health concerning diet in tuberculosis illustrate the consensus of medical opinion on this subject at the present time:

There is no question but that the consumptive needs an abundance of properly cooked, wholesome, digestible food, at suitable intervals. But consumptives are often advised to eat more than they should and to eat at too frequent intervals, and consumptives are too often "stuffed" with food. It is difficult to say how much a consumptive should eat, or how often he should be fed. Proper advice cannot well be given in an individual case without due regard to the patient's digestive powers, and the adequacy of his kidneys.

Many a patient who is losing weight on seven meals a day, will gain if the number be reduced to three or four.

Food should not be given to a consumptive, or to any one for that matter, while undigested food remains in the stomach.

The diet must be varied, and it must be borne in mind that a diet suitable for one consumptive may prove decidedly unsuitable for another. Individual tastes must be consulted. It is essential, however, that the patient be "made" to like certain articles of food to which he has formed a dislike, or concerning which he has formed wrong notions,—milk and eggs, for instance,—but too much should not be attempted at once.

Many patients dislike milk, which is an absolute necessity in the dietetic treatment of consumption. They say that it makes them bilious and constipated. Milk does not constipate, except possibly in small "doses." In large quantities, *i. e.*, one to three quarts a day, milk is a laxative, and as such is much appreciated by persons who have a tendency to constipation.

Patients will better appreciate the necessity for milk-drinking if it is explained to them that one glass of good milk contains as much nutritive material as two eggs, three ounces of lean meat, sixteen ounces of oysters, one ounce of cocoa or cheese, or two ounces of bread.

If a patient will eat three good meals a day—rare beef or mutton is excellent for a consumptive—and drink a few glasses of milk, say three, between meals, there need be no great anxiety as to the sufficiency of the diet. But solid food cannot be given with safety when the temperature goes above 101° F.

And many patients will not eat three good meals. So to those and others in the advanced stages of the disease who are losing weight rapidly, easily assimilated food must be given at more frequent intervals. Here milk and eggs will be found indispensable, alone, or as an adjunct to other food.

But while milk and eggs have helped many consumptives to health, neither of these nor any other articles of diet can be taken alone, for any continued period. The diet must be varied.

Sample Dietary.—The following dietary, subject, of course, to changes to suit the individual case, will give some idea of the food to be allowed a consumptive whose digestion is good:

7:00 A. M. Fruit, cereal, toast and butter. Two raw or soft boiled eggs, one or two glasses of milk.

10:00 A. M. Two glasses of milk, crackers, bread and butter or toast.

12:30 P. M. Soup, rare roast beef, or lamb or mutton, or turkey, or steak, or chicken, sweetbreads, one or two vegetables, like potatoes, beets, peas, beans, corn, spinach, cauliflower, asparagus, turnips. Bread and butter and chocolate, coffee or cocoa. A lettuce salad, with olive oil, if the patient likes it. Baked or stewed apples, bread pudding, rice, custard, junket, or the like. Almonds, walnuts, or pecans, form a valuable addition to the consumptive's diet.

4:00 P. M. Two glasses of milk, with one or two eggs. Bread and butter.

7:00 P. M. One or two glasses of milk. Two eggs. Bread and butter with jelly or jam. Meat may be given with the last meal, especially if the mid-day meal was light. Meat should never be cooked twice.

General Rules in Regard to Eating.—Food should be eaten slowly, and be well chewed. The consumptive must not "bolt" his meals.

Milk should be drunk slowly. It will be still better if it be sipped. The common way of drinking milk, in great swallows, one after another, is the principal cause of its being indigestible. The addition of a pinch of salt often makes the milk more palatable.

Eggs should be served in a variety of ways: raw, light boiled, poached, shirred, baked or light fried. But they are best when taken raw. If the patient gets a dislike to the taste of eggs, he should swallow them whole. This can easily be done by breaking the eggs in a glass, and covering them with milk or a little light wine and "tossing it off."

Butter is very fattening, and it is well for consumptive patients to partake freely of bread and butter, provided always that it does not upset the digestion.

If the patient is run down, fats should be given him. Butter and cream are excellent. So are fatty fish, eels, salmon, and sardines, also vegetables prepared with a great deal of fats. Give plenty of vegetables.

Horseradish, vinegar, mustard, lemon juice, etc., tend to stimulate the appetite.

Sometimes the digestive system becomes clogged, and the patient shows a disgust for food. Here it would be well to cut out eggs and milk for a week, and consult a physician, who may prescribe a laxative and a tonic.

To properly digest this number of meals, the patient must remain out of doors the greater part of the time.

Dr. Alfred L. Loomis gives the following good general rules to follow in relation to eating:

1. Food should be taken at least six times in the twenty-four hours; light repasts between meals and on retiring.

2. Never eat when suffering from bodily or mental fatigue or nervous excitement.

3. Take a nap, or at least lie down, for twenty minutes before the mid-day and evening meals.

4. Take only a small amount of fluid with the meals.

5. The starches and sugars should be avoided, as also all indigestible articles of diet.

6. As far as possible, each meal should consist of articles requiring about the same time to digest.

7. Eat only as much as can be easily and fully digested in the time allowed.

8. As long as possible systematic exercise should be taken to favor assimilation and excretion; when this is impossible massage or passive exercise should be undergone.

9. The food must be nicely prepared and daintily served; made inviting in every way.

Dietary for Those Having Large Appetites.—Dr. Albert P. Francine, in his recently published work on "Pulmonary Tuberculosis," suggests the following as a full dietary suitable for patients with large appetites and good digestion. Naturally small eaters could not follow this without modification, and here is emphasized the necessity for individualization:

7 A.M. One pint of milk and two raw eggs, taken in bed.

8:30 A.M. Breakfast. Fresh fruit, cereal, bacon, salmon, herring, or tender steak, chop or chicken; dry toast, wheat bread or corn bread; a pint of milk or cup of coffee, chocolate or cocoa.

10 A.M. One pint of milk and one raw egg.

12:30–1 P.M. Lunch (heaviest meal), preceded by half hour's rest. Thick soups—puree of vegetables, especially the albuminous legumen; a roast and vegetables; bread with plenty of fresh butter; simple desserts with sugar.

4 P.M. One pint of milk and one raw egg.

6 P.M. Supper, preceded by half-hour's rest. Light, simple meal, cold meats, light salads, tongue, sardines, etc. Pint of milk, or cup of weak tea, or cocoa.

9 P.M. One pint of milk and two raw eggs.

9:30–10 P.M. Patient goes to bed.

The patient will do better if he can have his meals at a table where others are eating and enjoying their food. But a consumptive should not be allowed to sit at a table with others, unless his hands and face have been *carefully washed,* and unless he is able to suppress his cough while at the table.

Pleasant surroundings, a cheerful dining-room, an inviting table with a clean cloth and napkins, palatable, well-cooked food attractively served, are all essentials in the dietetic treatment of consumption. "*Life is not to live, but to be well.*"

Use of Alcohol.—A few words in conclusion as to the use of alcohol (malt, beer, whisky, and the like) in consumption. Alcohol is now very seldom used in the treatment of consumption. It is wrong; it is foolish to imagine that alcohol has any specific action against consumption. Ordinarily the consumptive needs no alcohol. Usually he is better off without it. But there may be cases where the use of alcohol is permissible. The physician is the best judge. Alcohol should never be taken by a consumptive except on the advice of the family physician.

While many competent physicians would take exception to some of these directions and physiologists object to some of the principles of nutrition set forth, the statement as a whole well represents the results of experience. The supreme importance of the necessity of considering each patient separately in regard to his diet is well brought out.

No Universal Diet.—From a careful review of all the material which has been collected, it may be said that there is no definite system of diet which can be prescribed in all cases. In every instance the peculiar conditions and environment of the patient must be studied, and if a generous diet is decided upon, it must be selected with a view to exciting the least possible disgust or repugnance on the part of the patient. To this end the various nourishing foods just mentioned, and many others of like character, may be tried carefully for the purpose of seeing which is tolerated in the largest quantity by the patient. This having been determined, the overfeeding may be continued as long as there are no distinctly unfavorable symptoms developed. The very moment, however, that the digestive organs become so overloaded that they themselves become diseased by reason of the overfeeding, it is impossible to understand how its continuance could result in any benefit to the patient. This is another of the numerous cases in which it is apparent that general theories of diet cannot be rigidly applied in all cases in actual practice. That the patient should be nourished goes without saying, and to the greatest possible extent, but each case must be studied carefully by a competent physician in order to determine the character and quality of the diet best suited to the condition and idiosyncrasies of the patient.

ANALYSIS OF INFANTS' AND INVALIDS' FOODS.

(Compiled from Various Sources.)

Name of Food.	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Remarks.
				Soluble.	Starch.		
	%	%	%	%		%	
Albany Food, ...	8.60	9.50	2.10	79.40		0.40	Much unchanged starch.
Allenbury No. 1 Food, .	1.82	10.70	16.79	65.51	1.10	4.08	
	5.70	9.70	14.00	66.85	. .	3.75	
	83.30	1.56	2.30	7.20	. .	0.60	Ready for use.
Allenbury No. 2 Food, .	2.24	10.23	14.94	67.54	1.24	3.81	A malted meal plus No. 1 Food.
	3.90	9.20	12.30	72.10	. .	3.50	
Allenbury No. 3 Food, .	3.00	10.33	1.05	22.21	62.91	0.60	Partly malted wheaten flour.
	6.50	9.20	1.00	82.80		0.50	
American-Swiss Food, .	5.68	10.54	5.81	45.35	30.00	1.21	Much cane sugar.
Anglo-Swiss Food, . . .	6.50	10.26	4.91	46.43	29.48	2.02	Much cane sugar.
Bananina, ...	9.50	4.10	0.40	84.00		2.07	A banana flour.
Benger's Food, ...	11.29	10.43	1.10	9.90	66.30	0.96	Much digested in preparing.
Carnrick's Soluble Food,	5.17	16.69	5.53	28.11	41.50	3.00	Much unchanged starch.
Chapman's Whole Flour,	8.40	9.40	2.00	. .	79.30	0.90	A whole meal flour.
Cheltine Infant's Food, .	7.20	16.20	3.92	71.00		1.83	Contains much starch.
Cheltine Maltose Food, .	4.60	5.30	0.27	87.60	. .	2.25	Fully malted.
Coomb's Malted Food, .	7.90	12.10	2.80	76.80		0.40	Much unaltered starch.
Cremalto, ...	22.26	6.40	20.26	44.67		1.79	Cream and malt.
Diastased Farina, . . .	8.30	7.60	1.30	81.70		1.10	Carbohydrates said to be made soluble in preparation.
Fairchild's Milk Powder,	5.54	1.19	0.05	92.00	. .	1.22	Practically milk sugar.
Falona, ...	7.00	8.40	3.50	79.9		1.20	Cereals and a fat-containing bean.
Frame Food, ...	7.62	13.69	0.44	22.33	54.96	0.96	Not so rich in minerals as claimed to be.
Franco-Swiss Food, . .	4.43	13.00	3.70	46.09	30.86	1.42	Much cane sugar.
Horlick's Malted Milk, .	2.54	15.40	8.87	69.21	0.18	3.80	Desiccated milk, 50.0; wheat flour, 26.25; barley malt, 23.00; and sod. bicarb., 0.75.
(ready for use) Chittenden, ...	92.40	1.15	0.60	5.38	. .	0.29	
Horlick's Malted Food, .	9.70	10.43	0.34	76.83	2.20	. .	Almost completely malted.
Hovis Babies' Food, . .	3.70	7.70	0.20	86.60	. .	1.82	Fully malted.
Hovis No. 2 Food, . . .	2.40	5.70	0.10	90.10		1.70	Starch 7.5 per cent.
Imperial Granum, . . .	11.50	10.91	0.64	5.73	70.22	1.00	. .
I. and I. Food, ...	5.50	10.30	2.30	80.50		1.40	Mainly starch.
John Bull No. 1 Food, .	3.98	21.00	11.87	54.29	. .	5.32	Maltose, 21.32; lactose, 29.42; dextrin, 3.55.
John Bull No. 2 Food, .	1.68	11.06	0.68	37.65	43.30	1.74	Maltose, 23.31; dextrose, 1.32; dextrin, 5.38; lactose, 7.65.
Kufeke's Infant Food, .	8.37	13.24	1.69	23.71	50.76	2.23	Made in Germany.
Lahmann's Vegetable Milk, ...	24.40	7.50	24.60	41.80		1.50	Made from nuts and can be added to milk.
Loeflund's Cream Emulsion, ...	24.32	8.23	15.32	49.43	. .	2.60	A thick brown paste made from milk and malted wheat extract.
Maltico Food, ...	2.36	16.07	11.80	65.89		3.88	Composed of milk and malted cereals, no starch.
	1.63	15.19	17.19	63.00		2.99	
Manhu Infant Food, . .	8.80	8.70	5.60	75.90		1.00	Desiccated milk and malted cereals, much starch.
Mellin's Food, ...	12.37	10.07	0.18	68.18	. .	3.75	It is a desiccated malt extract from wheat and barley
	6.13	7.81	0.29	75.65	6.93	3.17	
	6.30	7.90	trace	82.00	. .	3.80	
Milo Food, ...	3.81	14.34	5.50	58.93	15.39	2.03	Desiccated milk with maltose and dextrins 27.36, and cane sugar 25 percent.
Moseley's Food, ...	10.84	14.78	1.84	21.76	49.06	1.72	Complete conversion during mixing.
Muffler's Food, ...	4.76	15.19	5.10	72.42		2.43	Desiccated milk, powdered white of egg, wheat flour and lactose.
	5.63	14.34	5.80	27.41	44.43	2.39	
Neave's Food, ...	5.03	13.20	1.70	4.71	74.27	1.09	Practically all starch.

ANALYSIS OF INFANTS' AND INVALIDS' FOODS.—(*Continued.*)

NAME OF FOOD.	WATER.	PROTEIN.	FAT.	CARBOHYDRATES. Soluble.	CARBOHYDRATES. Starch.	ASH.	REMARKS.
	%	%	%	%		%	
Nichol's Food of Health,	11.90	7.70	1.70	76.90		1.75	Mainly starch.
Nutroa Food,	6.80	15.90	10.30	66.00		1.00	Cereals plus peanut flour; hence the fat.
Opmus Food,	10.90	9.10	1.00	. .	78.60	0.40	A granulated wheat flour.
Ovaltine,	3.30	12.01	1.98	76.70	2.57	3.44	A Swiss product.
Phosphatine, Fallières,	5.85	2.35	1.92	56.68	31.98	1.22	Calcium phosphate, cane sugar and starch of potato, rice, arrowroot, sago, cocoa.
Ridge's Food,	9.23	9.24	0.63	5.19	77.96	0.60	Mainly starch.
Robinson's Groats,	10.40	11.30	1.60	. .	75.00	1.70	Ground oats, without husk.
Robinson's Patent Barley,	10.10	5.13	0.97	4.11	77.76	1.93	Ground pearl barley.
Savory & Moore's Food.	5.34	10.79	1.06	27.81	54.09	0.91	Wheat flour and malt; much grape and cane sugar.
	8.34	9.63	0.40	44.83	36.36		
Scott's Oat Flour,	5.80	9.70	5.00	. .	78.20	1.30	A fine oat flour.
Theinhart's Hygiama,	4.75	21.22	10.05	49.10	11.33	3.55	The fat is partly cocoa butter.
Triticumina Food,	8.60	12.50	2.20	75.7		1.00	Mainly starch.
Virol,	11.66	6.43	19.72	61.61	. .	0.58	The first analysis is the one given by the makers.
	24.04	4.16	10.75	59.25	. .	1.80	
Well's & Richardson's Food,	7.76	11.85	1.64	39.00	36.43	2.61	Partly malted. Contains much cane sugar and no milk.
Wheat Flour,	9.02	7.47	1.01	5.66	76.07	. .	. .
Wheat Flour, baked,	7.78	. .	0.41	14.29	67.60	.	. .
Worth's Perfect Food,*	2.40	11.10	2.00	83.50		0.50	. .
Dried Human Milk,†	. .	12.2	26.4	52.4		2.1	The standard of composition to which artificial substitutes should conform.
				SUGAR.			
Aylesbury Dairy Co.'s Humanized Milks, No. 1,†	89.43	1.3	4.0	4.7		0.49	. .
Aylesbury Dairy Co.'s Humanized Milks, No. 2,†	88.3	2.2	3.6	5.2		0.57	. .
Paget's Perfected Milk Food,†	88.04						
Gaertner's Fettmilch,†	. .	1.08	3.83	6.82		0.23	. .
Condensed Whole Milk		1.5	3.2	6.0		0.35	. .
(sweetened)	24.06	9.36	11.28	52.28		2.13	. .
Condensed Skim Milk,	29.23	10.73	.64	55.69		2.63	. .
Wells, Richardson & Co. Lactated Food,‡	6.95	9.56	0.42	29.65	51.38	1.04	. .
Charles Martin's Cardinal Food,‡	8.18	10.50	0.35	8.35	71.76	0.86	. .
Eskay's Albumenized Food,‡	1.70	7.25	4.95	58.65	26.47	0.98	. .
Lacto-Globulin,‡	9.85	71.44	0.65	11.65	. .	8.36	. .
Wampole's Milk Food,‡	3.35	14.18	7.10	71.30	. .	2.64	. .
Wemalta,‡	8.85	12.31	1.35	29.70	. .	0.78	. .
Triangle Food,‡	7.35	12.25	1.70	3.75	74.25	0.70	. .
English Milk Food, Malted,	5.75	8.38	0.70	30.30	53.95	0.92	
Baby's Own,‡	6.55	9.63	1.05	22.80	59.39	0.58	Requires addition of varying amounts of milk.
Christie's Food,‡	3.70	6.50	3.05	35.65	50.10	1.00	. .
Wyeth's Prepared Food,‡	3.00	14.69	1.30	68.30	7.21	3.50	.

* This and all preceding analyses are from A System of Diet and Dietetics, by G. A. Sutherland.
† From Food and the Principles of Dietetics, by Robert Hutchison.
‡ From Bulletin No. 185, Inland Revenue Department, Ottawa, Canada.

MEDICINAL FOODS.

(From The Journal of the American Medical Association for May 11, 1907.)

Name of Food.	Water.	Glycerin and Undetermined Matter.	Ash.	Protein.	Carbohydrates.	Alcohol by Volume.
	%	%	%	%	%	%
Carpanutrine,	61.00	28.45	0.93	4.28	5.34	15.5
Carpanutrine,	65.60	21.29	1.09	6.24	5.78	17.3
Liquid Peptones,	84.82	3.63	1.00	4.50	6.05	22.0
Liquid Peptones with Creosote,	77.60	4.34	0.75	3.84	13.47	22.0
Liquid Peptonoids,	83.34	0.23	0.93	4.93	10.57	17.5
Liquid Peptonoids	81.02	2.02	0.90	4.53	11.53	17.8
Predigested Beef,	89.67	3.40	0.18	2.38	4.37	19.7
Predigested Beef,	88.30	4.37	0.19	2.59	4.55	19.0
Nutrient Wine of Beef Peptone,	68.73	14.97	0.23	0.64	15.43	21.5
Nutrient Wine of Beef Peptone,	69.90	13.70	0.40	0.43	15.57	20.9
Nutritive Liquid Peptone,	83.39	1.02	0.84	1.86	12.89	23.0
Nutritive Liquid Peptone,	82.90	1.95	0.80	1.16	13.19	21.8
Panopepton,	78.00	2.60	1.10	6.38	11.92	18.5
Panopepton,	77.60	4.86	1.16	6.33	10.05	20.9
Peptonic Elixir,	81.24	3.21	1.55	2.54	11.46	18.8
Tonic Beef S. & D.,	79.72	12.91	1.61	3.40	2.36	14.9
Tonic Beef S. & D.,	80.33	12.63	1.54	3.28	2.22	16.1
Liquid Peptone,	96.33	.44	0.87	1.81	0.55	14.0
Cow's Milk (3.8 percent fat),	87.00	..	0.07	3.50	4.80	..

PART XI.

SIMPLE METHODS FOR DETECTING FOOD ADULTERATIONS.

GENERAL CLASSES OF ADULTERATION.

Simple Tests.—Many forms of adulteration are easily determined by simple tests that anyone, without the training of the professional chemist, may practice, using the ordinary apparatus found in the household and reagents which are constantly at hand or may be readily obtained at the drug-store. This subject has been treated in Bulletin No. 100 of the Bureau of Chemistry, U. S. Department of Agriculture, by W. D. Bigelow and Burton J. Howard, from both the chemical and microscopical points of view. Whenever these simple tests are applied, the operator should have at hand samples of the same articles of known purity, and apply the tests also to them. The results will serve as a guide in interpreting the reactions obtained on the article under inspection.

SOME FORMS OF FOOD ADULTERATION.

Gross Physical Adulterations.—Very often certain of the grosser adulterations of foods, as well as others whose detection is somewhat more difficult, may be detected by persons who are not trained in either chemistry or microscopy. If the adulteration is such that it is apparent to the eye, as, for instance, the admixture of two or more substances in sufficiently large particles to be identified, the detection is simply a question of ordinary inspection. The admixture of artificial coffee grains resembling generally in color and shape the natural coffee grains is a case of this kind, yet the distinctions are not always so great that the untrained eye, even by careful attention, can easily distinguish them. Many other mixtures of this kind are, or have been, on the market, and are generally capable of easy detection. When the state of subdivision is finer, it is still not beyond the power of the untrained eye to distinguish the difference, if an ordinary magnifying glass, which almost everyone may get, is used. Thus coarsely ground shells and fruit stones mixed with peppers and spices may be detected with a considerable degree of accuracy, by simple magnification. If, however, the detection of the adulteration depends on special and obscure structural relations, then even the magnifying glass or microscope will not reveal to the unpracticed eye the sophistication which has taken place. Nevertheless, some adulterated goods have certain physical traits, which, while not wholly convincing, may be at least sufficiently marked to arouse suspicion. It is advisable, therefore, that every person purchasing food make a careful study of its appearance; the neatness with which it has been put up; the cleanliness of the wrappers; the character of the general surroundings; the physical condition of the food itself; and the label which it bears. In fact, all accessories accompanying the food product are subjects for careful and patient investigation.

Chemical vs. Condimental Preservatives.—There are certain preservatives that respond to simple tests, which, while not absolutely final in the hands of a layman, at least may give grounds for a reasonable doubt as to the purity of the goods in question.

Certain condimental substances commonly exercise preservative effects to a limited extent, although they are not classified in the list of chemical preservatives. Among these may be mentioned the ordinary substances used to give flavor and character to food products, both fresh and preserved, such as salt, sugar, vinegar, spices of all kinds, essential oils, brandy, and smoke. These substances are recognized by physiologists and experts as having valuable qualities which render their use in food wholly legitimate. They tend especially to act upon the nerves of taste and smell, and thus to excite through these nerves the activity of the organs of the body that secrete the digestive ferments, without which the digestion and absorption of the food are impossible. While these substances if taken in very large quantities may be capable of exerting a deleterious influence, as may any food for that matter, they belong to an entirely different class from those preservatives which have neither taste nor smell and which cannot possibly be of any value in the process of digestion. The argument is frequently made that a chemical preservative which has neither taste nor smell is no more harmful than one of the condimental preservatives, such as common salt, and, therefore, if common salt be permitted, which is known sometimes to have injurious effects when used in excessive quantities, the chemical preservative should be admitted, provided it is not used in large quantities. The argument is not logical, and has no weight whatever when analyzed in the proper way.

Artificial Colors.—Another form of adulteration which may be detected sometimes without much difficulty is the use of artificial colors. The presence of these is excused by some writers on the ground that they come to the aid of digestion through the optic nerve, just as taste comes to its aid through the gustatory and odor through the olfactory nerve. There is some reasonable ground for this statement. It is true that the foods appeal to us very strongly by their color, provided the color is a natural one. When, however, it is known that the color which is seen in the food is of artificial production, it loses its esthetic appeal as well as its exciting effect upon the digestive organs. Its value, therefore, depends wholly on deception. The effect which is produced on the mind by a known artificial color in foods is rather one of disgust than of pleasure. Especially is this true since the vegetable colors, which are the only ones natural in foods, have been so largely supplanted by the artificial colors produced by chemical means. It follows, I think, without contention, that if we admit artificial colors at all in foods they should be of vegetable origin. The question of the propriety of admitting them has both a legal and an ethical aspect. The coloring of foods is illegal if it conceals inferiority or is in any way deceptive. The coloring of foods is contrary to the esthetic instinct if it is glaring, assertive, and intense. Usually in attempts to imitate a natural color in foods by artificial tints, Herod is out-Heroded, and the final tint is usually much more intense than that which nature paints. The general effect, therefore, of artificial colors is to affront the artistic nature of the consumer, and thus any possible benefit which could have come from the use of the tint is discounted. The only case in which it is tolerable to use artificial colors is in those compounded foods which of themselves have no natural color and which may be made, by tinting with a harmless color especially of vegetable origin, to appeal to the eye of the consumer. There are, however, very few foods of this kind, and I am strongly of the opinion that the eye would be better pleased in the majority of cases if all artificial colors were excluded from foods. There could not possibly any harm come to the consumer, and a great deal of good would be accomplished. To the real connoisseur there is nothing more repellent than to sit down to foods gorgeously and inartistically tinted and be expected to eat them with relish and enthusiasm.

These three forms of adulteration, namely, mixing, preserving, and coloring, are the most common forms, with perhaps the exception of the extraction of some valuable ingredient, or the addition of a neutral or inactive substance to dilute the strength of the natural product.

Obsolete Adulterations.—There are many forms of adulteration which are believed to exist, and which perhaps did exist once, that have not been practiced in this country, to any extent, for many years. In this category may be mentioned the old fable of the addition of sand to sugar, of gypsum and terra alba to flour, and of alum to bread. Flour has been adulterated in other ways, however. As stated in connection with diabetes, a great deal of so-called gluten flour is only ordinary flour with an exceptionally high content of crude protein. There has also been a large amount of adulteration by mixing two or more flours and calling the product by the name of the more expensive constituent, as, for instance, buckwheat made partially of rye or oat flour or both.

This brief summary of the common forms of adulteration is not intended by any means to exhibit the whole range of adulterated products, but to serve only as an introduction to some of the simple methods of detection.

MATERIALS AND REAGENTS.

Definitions.—The term "reagent" is applied to a chemical or an agent of some kind, by means of which definite chemical changes are produced which are more or less easy of observation. Some of the materials used in making simple tests, such as will be described, are as follows:

1. *Turmeric Paper.*—This is an ordinary white filter-paper made of pure fiber which has been cut into strips, dipped in a tincture of turmeric, and dried. It has the characteristic color of the turmeric itself.

2. *Alum.*—There are several alums which may be used for chemical purposes. The ordinary iron, potassium or ammonium alum may be used for all simple tests.

3. *Hydrochloric Acid.*—This is a substance which is usually called "muriatic acid," and can be obtained at any drug-store. All tests in which hydrochloric acid is used should be conducted in glass or stoneware, as this acid will attack many metals, such as iron, tin, zinc, etc. It does not, however, attack silver or gold. Care must be exercised not to spill any of the acid over the skin or clothing, as it will burn both.

4. *Iodin.*—The ordinary tincture of iodin of the drug-store is used.

5. *Potassium Permanganate.*—These bright colored crystals, which give a purple red solution, can be obtained at any drug-store. Dissolve about one part of the crystals in 99 parts of water.

6. *Alcohol.*—Pure alcohol, whether distilled from grain or other sources, can be used.

7. *Chloroform.*—The ordinary reagent used for producing anesthesia is employed.

8. *Boric Acid or Borax.*—This is a very common chemical, kept in almost every house.

9. *Ammonia Water.*—This is the very common reagent kept for cleaning purposes, especially for removing grease spots.

10. *Halphen Reagent.*—This is a reagent by means of which cottonseed oil can be detected. In this case it would be advisable to have the reagent prepared by the druggist according to the following formula: Dissolve one-third of a teaspoonful of finely divided sulphur in from three to four ounces of carbon bisulphid and mix the solution with an equal volume of fusel oil (amyl-alcohol). This reagent must be used with as much care as gasoline, as it is very inflammable.

TESTS FOR DETECTING CHEMICAL PRESERVATIVES.

Boric Acid.—Boric acid or borax may be easily detected when present in such commodities as sausage, butter, or milk, in which it was often used before the enactment of the Food and Drugs Act. If the boric acid is in meat, a small sample should be rubbed thoroughly with a little water, which dissolves a large part of the preservative, and the liquid filtered to remove the solid matter. In the case of butter a teaspoonful is placed in a cup with double the quantity of hot water, which will melt the butter. After melting, the contents of the cup are well stirred with a teaspoon and set aside in a cool place until the butter solidifies. The butter will be attached to the spoon and can be lifted out, the remaining liquid being strained through a white cotton cloth or filter-paper. It is not necessary that all the liquid should pass through, but only a sufficient quantity to get the test. In the case of milk, two or three tablespoonfuls are mixed with twice that quantity of a solution of a teaspoonful of alum in a pint of water, shaken vigorously, and filtered.

Applying the Test.—About a tablespoonful of the liquid, obtained by treating the sample as just described, is placed in a dish with five drops of hydrochloric acid. A strip of turmeric paper is dipped into the liquid and afterward removed and held in a warm place, but not warm enough to char the paper, until dry. In the case of the presence of boric acid or borax, the turmeric paper assumes a bright cherry-red color on drying. If now a drop of ammonia is added, the red color changes to dark green or greenish-black. This test will be found satisfactory even in the hands of a beginner.

Benzoic Acid.—Among the substances most frequently preserved with benzoic acid may be mentioned tomato catsup as well as mincemeat, certain fruit juices, etc. In acid media, such as catsup, the benzoate of soda is decomposed and free benzoic acid is produced. If any considerable quantity of benzoate of soda has been used in tomato catsup, it can be detected by setting aside in an ordinary dish in a warm place, as, for instance, near a radiator, covering to keep out the dust, and allowing to stand for a few days, so that the evaporation goes on very slowly. As the concentration takes place beautiful lamellar crystals of benzoic acid are formed. These sometimes grow up from the magma to the height of a half inch or even more. If the content of benzoic acid is very small, it may be extracted by acidifying and shaking with chloroform and then be set aside in a cool place to evaporate. The chloroform should be subjected to only a gentle temperature, so that the evaporation may be slow. The characteristic appearance of the lamellar crystals as before indicates the presence of benzoic acid.

Saccharin.—Saccharin is a very sweet substance prepared from coal-tar and has been used largely for sweetening purposes instead of sugar. One part of saccharin is said to have as much sweetening power as 400 to 500 parts of sugar. Saccharin has some preservative power also, but is never used solely for this purpose, the preserving influence being only incidental. In the detection of saccharin the substance containing it, which is usually a liquid, is shaken with chloroform, which settles to the bottom and is removed by means of a medicine-dropper. The saccharin enters into solution in the chloroform, while sugar, if present, does not. The chloroform solution is then evaporated by heating gently, and if saccharin has been present the residue has a distinctly sweet taste. This method is not applicable to substances whose chloroform layer contains a flavor that would mask the sweet taste of the saccharin, as, for instance, ginger ale.

Salicylic Acid.—Salicylic acid at the present time is scarcely used at all in this country in preserving foods. It was formerly found in the same class of foods which are now preserved by benzoic acid. The detection of salicylic acid is a very simple matter. Solid and semi-solid foods, such as jelly, should be mixed with sufficient water to make a thin liquid. In the case of food containing insoluble material, such as jams, after macerating for some time the liquid portion may be separated by straining through a piece of white cotton cloth. A gentle heat may be used, if desirable, during the macerating process. Two or three ounces of the liquid obtained as described are placed in a narrow bottle holding about 5 ounces with about a quarter of a teaspoonful of cream of tartar, or, better, if at hand, a few drops of oil of vitriol (sulphuric acid). The mixture is well shaken for two or three minutes and again filtered into a second bottle. To this filtered liquid three or four tablespoonfuls of chloroform are added and the contents mixed by a vigorous rotary motion. After well mixing, the contents of the bottle may be poured into an ordinary glass tumbler and allowed to stand until the chloroform settles to the bottom, it being heavier than water. Shaking should be avoided as much as possible, since it causes an emulsion of the chloroform with the water which is difficult to break up. The chloroform layer contains the salicylic acid, if any is present, and should be removed from the aqueous liquid by means of an ordinary dropping tube, or a glass tube with a small opening and a bulb, into which the chloroform can be sucked. This chloroform mixture is placed in a small tube with a little water and a small fragment, not much larger than a pinhead, of iron alum. The contents of the tube are thoroughly shaken and again allowed to stand until the chloroform settles to the bottom. If salicylic acid is present, the upper portion of the liquor will assume a purple or purplish color.

DETECTION OF ARTIFICIAL COLORING.

Copper.—The presence of copper in foods is very easily detected. It is usually employed only for the purpose of producing an intense green color in goods which are naturally green, such as green beans, peas, etc. In this case, add a drop or two of hydrochloric acid, mix thoroughly, and place a bright steel knife-blade in the solution. If copper salts are present, copper, easily recognized by its reddish color, will be deposited upon the knife-blade. If it is not desired to coat a knife-blade, a bright iron or steel nail will serve the same purpose.

Caramel.—Caramel is often used to color freshly made distilled liquors so as to give them the appearance of great age. It is also employed to simulate the natural colors in flavoring extracts, such as vanilla, and in fact is very commonly used whenever it is desired to produce a red or brownish-red color in food products in general, both solid and liquid. Caramel is produced by heating sugar to a high temperature until it is partially decomposed. In this condition sugar to a great extent loses its sweet taste and its solubility in water.

To detect caramel two test-tubes or small bottles or phials of equal size and shape are employed, and two or three tablespoonfuls of the suspected sample are placed in at least two of these bottles. To one is added a teaspoonful of fuller's earth, which can be secured at any drug-store. The mixture is thoroughly shaken for two or three minutes and filtered through filter-paper, the first portion of the filtered liquid being returned to the filter-paper and the sample finally replaced in the original test-tube or bottle. The filtered liquid is compared with the untreated sample, and if the former has lost a good part of its color, it may be taken for granted that the color of the original article was largely due to caramel, since this body is removed to a large extent by the fuller's earth.

This test is a little more difficult than those which have preceded it, and, of course, would not be conclusive in the case of bodies which contain natural caramel; in other words, such as are prepared in any way with sugar which is subjected during the process of manufacture to a high temperature capable of converting a portion of the sugar into caramel. For instance, in the drying of malt the heat is often such as to partially char the malt, and the products made from this malt, such as malt vinegar, might show the presence of caramel when it had not been added thereto. Again, in the roasting of coffee a considerable quantity of caramel is produced by the action of heat on the sugar which the coffee bean contains. Hence, the presence of caramel in roasted coffee would not be evidence that it had been added as an adulterant, or otherwise.

Turmeric.—Turmeric is often used to give a yellow color to such preparations as mustard, especially if the mustard has been adulterated with flour or other white substances. In this case it has been quite a common practice to restore the color of the mixture to the normal yellow color of the mustard meal itself, and turmeric is one of the most common of the coloring-matters used for that purpose. In the detection of turmeric, a teaspoonful of the suspected sample is thoroughly stirred with a small quantity of alcohol and the mixture is allowed to stand for fifteen minutes, or until there is a distinct separation—the turbid or solid matter settling and leaving a practically clear liquid above it. This alcoholic solution is then poured into a clean glass or bottle. About one-third of a tablespoonful of the liquid thus prepared is used for the experiment and is placed in a clean dish and mixed with four or five drops of a concentrated solution of boric acid or borax and about ten drops of hydrochloric acid, by stirring well with a splinter of wood. A wedge-shaped strip of filter-paper, about two or three inches long, one inch wide at the upper end, and one-fourth inch at the lower end, is then suspended in the liquid so that the narrow end is immersed in the solution, and is allowed to stand for two or three hours. If, while the paper is suspended in the liquid, air is allowed to circulate around the mixture, it is better. If turmeric is present, a cherry-red color forms on the filter-paper a short distance below the upper limit to which the liquid is absorbed by the paper, and at times an inch or more above the surface of the liquid itself. A drop of ammonia changes this red color to a dark green, as in the case of the test for borax just described. In fact, the test for turmeric, as is seen, is exactly the same as the test for borax, the only difference being in the unknown substance to be determined.

DETECTION OF SOME COMMON ADULTERANTS.

Cottonseed Oil.—Cottonseed oil has been one of the most common adulterants for olive oil, but the ease with which it is detectable and the rigidity of State and national laws have reduced this fraud very greatly. Nevertheless, cases are occasionally found where admixtures of cottonseed oil with olive oil have been made. It will be useful, therefore, to give a simple and yet reliable test for the presence of cottonseed oil, which will detect even minute additions of this adulterant to olive oil. The test which is employed is known as the "Halphen test," from the name of its discoverer. The danger attending the use of the Halphen reagent has already been described. The test is applied as follows:

Two or three tablespoonfuls of the Halphen reagent are mixed in a bottle or glass vessel with an equal volume of the suspected sample of oil and heated, with precautions to avoid the burning of the reagent, in a vessel of boiling salt solution, prepared by dissolving one tablespoonful of salt in a pint of boiling water, the boiling continuing for from ten to fifteen minutes. At the end of this time, if even a small percentage of cottonseed oil is present, the mixture will be of a distinct reddish color, and if the sample consists largely or entirely of cottonseed oil, the color will be deep red.

Glucose.—Glucose is very commonly used as a substitute for sugar in the making of jams, jellies, preserves, and confectioner's goods. The method of detecting glucose in jellies, jams, etc., is as follows:

Place a teaspoonful of the jelly in a glass or bottle with two or three tablespoonfuls of water; set the vessel in hot water in order to hasten the solution. In the case of a jam or marmalade, after adding the water the solution is filtered to separate the insoluble matter, and is then allowed to cool. An equal volume, or a little more, of strong alcohol is added. If the sample is a pure fruit product, the addition of alcohol causes no precipitation, except that a very slight amount of proteid bodies may be thrown down. If glucose has been employed in the manufacture of the article, however, a dense white precipitate (dextrin) separates and after a time settles to the bottom of the liquid.

Glucose in molasses, sirups, honies, etc., may be more certainly detected by the coloration produced by iodin. The starch from which glucose is made gives a blue coloration with iodin. As the starch disappears the blue color fades, and when glucose is reached the color changes to a red tint, due to the presence of erythrodextrin in the mixture. The suspected sample is dissolved in water and treated with a small quantity of iodin solution. If glucose be present the color produced is red or violet according to the nature of the glucose present and its quantity. A blank test with honey, sirup, or molasses known to contain no glucose should be made for comparative purposes.

Often the substance to be examined has a red color of its own and in this case proceed as follows:

Place a small quantity of the substance in a small glass, dilute with a little water in the case of a molasses, but with a sirup this is not necessary, and precipitate with 95 percent alcohol, shaking all the time or until no more precipitation occurs. Allow to settle, then decant the clear liquid, take up the residue with the smallest quantity of water that will dissolve it, and heat, if necessary, to complete the solution. Cool, and reprecipitate with 95 percent alcohol. Decant, dissolve the gum again, using the smallest quantity of water practicable and heating if necessary. Cool, add a drop of hydrochloric acid to render the brown coloring substances soluble in alcohol, then precipitate all the gums with strong alcohol. Allow the gums to settle, then decant. Wash with strong alcohol, and dissolve in a small quantity of water; if still colored repeat the hydrochloric acid treatment or filter the liquid through animal charcoal. This should give a clear water-white solution, to which, in a test tube, add an iodin solution. To another test tube of the same size and containing the same quantity of water add the same amount of iodin solution. Note the two colors produced. If glucose is present the water solution of gums will be a dark red while the plain water solution varies in color from yellow to a light reddish-yellow, according to the strength of the iodin.

Invert-sugar in Honey.—Since honey is composed almost entirely of invert-sugar, the practice of adulterating it with this substance has come into use, but happily not very generally. Invert-sugar in honey may be detected by a very simple test. The reagent used is anilin acetate prepared by shaking equal parts of anilin and water and adding enough strong acetic acid to clear the mixture. The reagent is prepared fresh for each day. To a small quantity of strong honey solution add a less quantity of the reagent by allowing it to flow down the sides of the vessel so as to form a layer on top of the honey. Turn the vessel gently so as to mix the two solutions on the plane of contact. The formation of a red color at the surfaces of contact of the two solutions indicates the presence of invert-sugar. If honey be strongly heated for some time it will give the same reaction, but such treatment will spoil its flavor. This coloration is due to the formation of minute quantities of furfurol when sugar is heated. The test should be compared with a genuine honey.

Starch in Jellies.—Starch is sometimes used in cheap jellies as a thickener. A teaspoonful of the jelly is dissolved in a teacup, adding enough water to half fill it, and the contents are heated to boiling. While boiling, a solution of potassium permanganate is added, drop by drop, stirring constantly with a teaspoon, until the solution is almost colorless. The mixture is allowed to cool, and to hasten the cooling the vessel may be placed in cold water. It is then tested with a drop of the tincture of iodin. If the jam or jelly contains any starch, a blue color will be produced. Starch may be a natural constituent of some fruits, as apples, and hence the blue color produced may not be a positive proof of the addition of starch.

Starch in Spices and Condiments.—The test for added starch in condiments is rendered the more difficult because most of the condimental substances, that is, the several peppers, etc., contain starch of their own. The only way to distinguish in this case is by means of the microscope, and this can only be used with success in the hands of a skilled observer. There are spices, however, which contain no starch, such as cloves, mustard, and cayenne pepper, and in these products added starch can be readily detected by means of the iodin test already described. To conduct the manipulation a half teaspoonful of the spice is stirred into half a cupful of boiling water and the boiling continued for two or three minutes, by means of which any starch which may be present is reduced to a state which is more or less soluble. After cooling, artificially or otherwise, if the color is dark the mixture should be diluted with water, thus reducing the color so that the characteristic blue tint of the reaction may be seen. The test is made as already described, by dropping a small portion of the iodin mixture into the boiled and cooled spice and watching the effect. The appearance of a pronounced blue color is a positive indication that starch has been added.

EXAMINATION OF CERTAIN FOODS FOR ADULTERATIONS.

Coffee.—A number of simple tests for the presence of adulterants in ground coffee may be given. If the coffee is not ground, a careful inspection of the beans will disclose the number of imperfect, split, or defective beans, or the presence of grit, gravel, dirt, or foreign bodies of any kind. By picking out these imperfect and foreign bodies, and weighing them, the relative amount of adulterants present is determined, or it may be estimated with a good deal of accuracy simply by inspection. This method will also detect any artificial beans, if they are present. The price of coffee has been so low, however, for a number of years that it has not been profitable to manufacture imitation coffee beans of any kind. When the coffee is ground, however, the presence of adulterants, such as chicory, is more difficult to ascertain. The difference between the genuine ground coffee and the adulterated article may, however, be sometimes detected by simple inspection without the aid of the microscope. This is particularly true if the product be coarsely ground or crushed, but the difficulty of this kind of inspection increases with the fineness of the grinding. Ground coffee has a uniform appearance, whereas if beans, peas, cereals, chicory, etc., have been added, the heterogeneous character of the mixture is more or less evident. By the use of the magnifying glass the adulteration is still more apparent. It is even possible, with a sharp-pointed instrument such as a penknife, to pick out the particles which are not coffee. Chicory particles especially are easily detected, as they are dark looking, gummy, and not granular in character. They stand out in strong contrast to the particles of coffee and also to the other adulterants which have been mentioned. Chicory particles have a bitter and somewhat astringent taste, which is easily distinguished by those who are familiar with it. The real coffee particles have a distinct appearance. They usually have a dull surface, whereas some of the coffee substitutes, such as peas and beans, often present a polished surface.

Test in Water.—After the gross inspection has been made by the eye or with the aid of the magnifying glass, a portion of the ground coffee may be placed in a glass or other vessel partly filled with water, and the mixture well shaken. The vessel is then set aside for a moment and its appearance observed. Pure coffee contains a large quantity of oil, and for this reason the greater number of the particles will float in water. Nearly all of the coffee substitutes, however, are heavier than water, and will sink to the bottom, carrying with them, of course, some of the particles of the real coffee. In this way a very fair idea of the purity of the coffee is obtained. It may be certain, in testing ground coffee in this way, that if there is a very large deposit the coffee is adulterated.

Color Test for Chicory.—Chicory mixed with ground coffee can be detected by a water test, usually with considerable ease. The suspected sample is dropped, a few particles at a time, into a glass of water, and, being slightly heavier than water, they sink, leaving behind them a brownish streak. This test, however, must be made with some care, as it is apt to lead to errors in the hands of persons who are not well acquainted with the characteristic colorings of chicory. It is advisable to get some pure chicory and pure coffee and experiment with each separately, and then with the mixtures of known proportions of each, to train the eye to observe the various phenomena. When this is done, the test becomes very useful.

Test for Cereals, etc.—Coffee is distinguished from the cereals and leguminous seeds which are usually substituted for it by the fact that it contains no starch, while the cereals and legumes, such as peas and beans, contain very large quantities. Even when the coffee and its substitutes are roasted, there may be enough starch present to respond to the test, which is extremely simple. The method given above for the detection of starch in spices and condiments is used to detect cereals in coffee.

If the sample contain much starch, the dilution before testing should be carried to a greater degree. Care must be taken to add only a drop of the tincture of iodin at first; but if no blue color is developed, more may be used.

Canned Goods.—Canned goods in the United States are very rarely adulterated, either with coloring-matter or with any added substances such as preservatives. The only examination, therefore, of canned goods that may be made with profit, is of the condition of the can, to see if it has been properly sealed, or to determine whether the contents of the can have acted on the tin. For this purpose the can should be cut open and the inner surface of the tin examined. If it appears to be corroded and is covered with figures of various kinds, the contents of the can may have dissolved quantities of the tin which may be deemed injurious, but this deduction is not always correct.

More important yet is the examination of the can to see if it has been perfectly sterilized as well as sealed. This is especially true of cans which contain lobster, fish, and similar products. There is no kind of food in which decay is more dangerous, as it is attended often with the development of ptomains, which are powerful poisons. If the can is found to bear the trace of only partial sterilization, or of imperfect sealing, as determined by appearance, taste or smell, it should be at once rejected. Especial attention should be paid to the behavior of a can when a small hole is made in it preparatory to opening. If an escape of gas is noticed, the contents of the can should be rejected. Rusty, old, and soiled cans should be looked upon with suspicion. There is no simple way of determining the quantity of tin or lead in canned foods. The presence of these bodies may be avoided by using a can lacquered on the inside or one made of glass. In general, the canned goods on the market are in excellent condition. Any possible danger may be avoided by the careful examination of cans and their contents before they are offered for consumption.

Eggs.—It is highly important that eggs be examined for the grosser forms of decomposition. By a cultivated taste, perfectly fresh eggs may be distinguished from eggs which have been properly kept in cold storage for some time. But where marked changes have gone on in the egg substances, due to storage, either with or without refrigeration, there are certain other characteristics developed which can be easily determined. The most important of these tests is what is known as "candling." This consists in holding the egg between the eye and a proper light and observing the illumination within the shell. The room should always be darkened. If dark spots are found in the egg, it is certain that it is not perfectly fresh, since a fresh egg presents a homogeneous, translucent, and attractive appearance. Moreover, there is found in the larger end of a fresh egg, between the shell and the lining membrane, a small air cell which is distinctly transparent. In an egg which is not perfectly fresh this space, unless the egg is stored with the large end up, becomes filled with egg substance and presents the same appearance as the rest of the egg. Eggs which have been stored a long time and not properly turned tend to show the yolk on the underside, often adhering to the shell itself, and this is always an indication that the egg has been stored and kept still at the same time. The best of all tests, however, is to open the egg and examine its general appearance, its mobility, and its odor and taste, and by these means determine whether or not it is fresh or stored. Eggs which have been stored some time show a tendency in the white and yolk to run together, and whenever this phenomenon is noticed, it may be certain that the egg, if the hen has been properly fed, is not a fresh one, although no perceptible odor of decay may be developed.

The Salt Solution Test.—Perfectly fresh eggs will just sink in a 10 percent salt solution at 70° F. This test is quickly applied and will distinguish the really fresh egg from one which is even a few days old. It is possible also to apply the sinking and floating test on a large scale. Salt water tanks of any size are easily constructed into which hundreds of dozens of eggs may be placed at once, thus effecting a speedy separation of sinkers and floaters, and at a minimum expense. There are some instances where a fresh egg will not sink in these circumstances, but such cases are not numerous enough to be of any importance. It is claimed, however, that this treatment impairs the keeping quality of the eggs when placed in cold storage.

Flavoring Extracts (Vanilla and Lemon).—Vanilla extract is one of the most common of the flavoring materials employed in the home. In the past few years it has also been one of the products most frequently adulterated, and many imitations or substitutes for vanilla extract have been sold under the name of the extract itself, as vanilla flavor, etc. The true product is made by extracting vanilla beans with alcohol, and the flavoring matter consists of an alcoholic solution of vanillin, which is the chief flavoring ingredient of the vanilla bean, together with other constituents of the bean soluble in alcohol which are classed principally under the head of resins. These resins, although present in a very small amount, and having only a slight flavor in themselves, are yet able to affect very materially the flavor of the product.

Common Adulterants.—One of the most common adulterations of vanilla is an extract made from the tonka bean, which in some respects resembles that of the vanilla bean, but is much cheaper and is far inferior in flavoring properties. It has a marked penetrating, almost pungent odor, in sharp contrast to the flavor of the vanilla extract. By having at hand a little vanilla extract of known purity, and a genuine tonka extract, anyone can very readily discriminate between them by their odor and taste.

Artificial Vanillin.—Another adulterant of vanilla extract is artificial vanillin, a synthetic product. Extracts made of this substance contain no resins, which is one of the means of determining whether or not the vanillin used is an artificial preparation. Extracts made from artificial vanillin are decidedly inferior in all valuable qualities to the true vanilla extract and are generally colored so as to imitate the natural product. Caramel is the usual coloring-matter employed, and its presence can be detected by shaking and observing the color of the resulting foam after a moment's standing. The foam of pure extracts is colorless. If caramel is present, a color persists at the points of contact till the last bubble has disappeared.

Examination of the Resin.—If pure vanilla extract slightly acidified with acetic acid be evaporated to about one-third its volume, the resins, which were before in solution, are separated and settle to the bottom of the vessel. On the other hand, artificial extracts remain clear under the same treatment. In the examination of vanilla extract the character of these resins is studied. For this purpose a dish containing about an ounce of the extract is placed over a teakettle or other vessel of boiling water until the liquid evaporates to about one-third or less of its volume. The alcohol having been by this time all driven off, the resins become insoluble and separate. Water is added to bring the liquid back approximately to its original volume. This separates the resins, which will be thrown out as a brown flocculent precipitate. A few drops of hydrochloric acid are added, the liquid is stirred, and the insoluble matter allowed to settle. It is then filtered, and the resin on the filter-paper is washed with water and afterward dissolved in a little alcohol. To one portion of this solution is added a small particle of ferric alum, and to another portion a few drops of hydrochloric acid. If the resin is that of the vanilla bean, neither ferric alum nor hydrochloric acid will produce more than a slight change in color. With resins from most other sources, however, one or both of these substances causes a distinct color change.

Lemon Extract.—Lemon extract is a flavoring material made by dissolving oil of lemon in strong alcohol. If oil of lemon is poured into dilute alcohol, large quantities of its constituents are separated, but they are held in solution if the alcoholic strength of the extract does not fall below 80 percent. Alcohol is, therefore, one of the most valuable constituents of lemon extract, for without it the product would be precipitated and unusable. Owing to the fact that lemon extract is a 5 percent solution of oil of lemon in strong alcohol, the sample may be examined by simply diluting with water. A teaspoonful of the extract is placed in the bottom of a glass tumbler and two or three teaspoonfuls of water added. If the sample is real lemon extract, the lemon oil will be thrown out of solution by reason of its insolubility in the alcohol after its dilution with water. The first result is a marked turbidity, and later the separation of the oil of lemon on the top of the aqueous fluid takes place. If the sample remains perfectly clear after the addition of water, no marked turbidity being produced, it is undoubtedly a very low-grade product, and contains little, if any, of the real oil of lemon.

Flour.—Within the last decade a process for artificially bleaching flour has been quite widely introduced. A bleached flour is of a dead white color, and the loaf of bread baked therefrom is usually a dingy white, and not a faint amber as would be expected from a natural flour. The bleaching process results in the addition of small amounts of nitrogen peroxid and renders the oil present nearly colorless instead of yellow. On these two facts the following tests are based.

Method I (for Nitrites), Solutions.— (1) Dissolve 0.5 gram (7.7 grains) of sulphanilic acid in 150 c.c. (5 oz.) of dilute acetic acid (about 20 percent). Keep well stoppered. (2) Dissolve 0.2 gram (3.1 grains) of alpha-naphthylamin hydrochlorid in 20 c.c. (0.7 oz.) of strong acetic acid (glacial), and add 130 c.c. (4.4 oz.) of dilute acetic acid (20 percent). Keep well stoppered. Mix 1 and 2 for use. These reagents should be prepared by a pharmacist. The mixed reagent keeps for several weeks.

Preliminary test: The water to be used should first be tested for nitrites by adding to a 4-ounce bottle of water about one teaspoonful of the mixed reagent. If after shaking and allowing to stand for about twenty minutes the solution remains colorless or is a very faint pink color, the water is suitable for making the following test. Distilled water is best for this purpose if obtainable.

Determination: Place a heaping teaspoonful of the flour to be examined in a wide-mouth, glass-stoppered, 4-ounce bottle. Nearly fill with water and add about a teaspoonful of the solution. Stopper the bottle and shake vigorously for a few minutes; then allow to settle for from fifteen to twenty minutes.

Under these conditions bleached flour will impart to the liquid a color ranging from a light pink to a deep red, depending on the degree of bleaching; unbleached flour should give no more color than the water alone. If a flour that is known to be unbleached can be obtained, it is well to make the test on this at the same time, for purposes of comparison.

Method II (for Color of Oil).—Place 2 heaping teaspoonfuls (20 grams) of the flour in a wide-mouth, glass-stoppered, 4-ounce bottle, nearly fill the bottle with gasoline, shake, and allow to settle. If the flour is unbleached, the gasoline will become distinctly yellow; if bleached, it will remain nearly colorless. It is well to conduct this test also with a known unbleached flour for comparison. This experiment must not be made in a room where there is any kind of fire, flame or spark.

Vinegar.—Vinegar has been subjected to many kinds of substitution, imitation, and adulteration. The term vinegar in this country is, by common consent, and also by the statutes of several of the States and by the regulations of the United States Department of Agriculture, applied to cider vinegar. In France the principal vinegar employed is made from wine, while in England it is usually made from malt. The tests applied in this country, therefore, are to determine whether the product is made from cider or not. Vinegar made from wine has a distinct wine odor; on the other hand, cider vinegar has the peculiar odor of the apple. If the vinegar is evaporated slowly almost to dryness, the characteristic odor of the malt, or wine, or cider vinegar can be very readily detected in the warm residue. The residue from cider vinegar will smell something like baked apples, and that from wine like grapes. If the vinegar, however, is made from what is known as distilled vinegar, the color of the residue will be very dark, almost black, and the odor will be entirely distinct from that of the other vinegars mentioned. The test may be continued further by heating the dish until the residue commences to burn. In this test the residue from cider vinegar will have the odor of scorched apples, while distilled vinegar, which has been colored with caramel, will have the odor of burnt sugar. Unfortunately, however, the low-grade vinegars often have a small amount of concentrated apple juice added to them, and this, of course, obscures these physical tests to a certain extent. They will, however, enable a person unskilled in chemistry to distinguish perfectly between cider vinegar, malt vinegar, wine vinegar, and distilled vinegar made by the acetification of dilute alcohol.

How to Distinguish Genuine Butter from Renovated.—*The boiling test.*—An important means employed in distinguishing between genuine and renovated butter is the boiling test. This test distinguishes between genuine butter on the one hand and oleomargarine and renovated butter on the other; and, fortunately, it is so simple of execution that it can be employed in any kitchen almost as well as in the laboratory, and requires no special skill on the part of the operator. It consists merely in boiling briskly a small portion of the sample and observing its behavior the while.

The test may be conducted as follows: Using as the source of heat an ordinary kerosene lamp, turned low and with chimney off, melt the sample to be tested (a piece the size of a small chestnut) in an ordinary tablespoon, hastening the process by stirring with a splinter of wood (for example, a match). Then, increasing the heat, bring to as brisk a boil as possible, and after the boiling has begun, stir the contents of the spoon *thoroughly*, not neglecting the outer edges, two or three times at intervals during the boiling—always shortly before the boiling ceases. In the laboratory a test tube, a spoon, or sometimes a small tin dish, is used in making this test.

A gas flame, if available, can be used perhaps more conveniently than a kerosene lamp.

Oleomargarine and renovated butter boil noisily, sputtering (more or less) like a mixture of grease and water when boiled, and produce no foam, or but very little. Renovated butter produces usually a very small amount.

Genuine butter boils usually with less noise, and *produces an abundance of foam.*

The difference in regard to foam is very marked, as a rule. Rarely, a butter is found which yields an uncertain result; such a butter should receive the attention of the grocer.

To Distinguish Oleomargarine from Renovated and Genuine Butters. —*Utensils required.*—The utensils required in the test to distinguish oleomargarine from renovated and genuine butters are as follows:

(1) A one-half pint tin "measuring cup," common in kitchen use, marked at the half and quarters; or a plain one-half pint tin measure, ordinary narrow form; or an ordinary small tin cup, 2¾ inches in diameter and 2 inches in height, holding about one gill and a half.

(2) A common kitchen pan, about 9½ inches in diameter at the base.

(3) A small rod of wood, of the thickness of a match and of convenient length for stirring.

(4) A clock or watch.

The process.—The process for distinguishing oleomargarine from renovated and genuine butters is as follows:

Use sweet skimmed milk, obtained by setting fresh milk in a cool place for twelve to twenty-four hours and removing cream as fully as possible. Half fill with this milk the half-pint cup or measure, or two-thirds fill the smaller cup mentioned, measuring accurately the gill of milk when possible; heat nearly to boiling, add a slightly rounded teaspoonful of the butter or butter substitute, stir with the wooden rod, and continue heating until the milk "boils up," remove at once from the heat and place in the pan (arranged while milk and fat are heating) containing pieces of ice with a very little ice water, the ice to be mostly in pieces of the size of one to two hen's eggs (not smaller, as small fragments melt too rapidly) and sufficient in quantity to cover two-thirds of the bottom of the pan; the water to be in quantity sufficient, when the cup is first placed in the pan, to reach on the outside of the cup to only one-fourth the height of the milk within; any water in excess of that amount must be removed. This refers to the condition at the beginning of the cooling; later, as the ice melts, the water will rise to a higher level. Stir the contents of the cup rather rapidly, with a rotary and a cross-wise motion in turn, continuously throughout the test, except during the moment of time required for each stirring of the ice and water in the pan, which must be done thoroughly once every minute by the clock. This is done by moving the cup about, in a circle, following the edge of the pan. Proceed in this manner for ten minutes, unless before that time the fat has gathered or has allowed itself to be easily gathered, in a lump or a soft mass, soon hardening. If it so gathers, the sample is oleomargarine; if not, it is either genuine or renovated butter.

The boiling test enables one to distinguish in the great majority of cases between genuine butter on the one hand and oleomargarine and renovated butter on the other; the Waterhouse test, household adaptation as just given, enables one to distinguish between the two last named; and so, by the use of the two tests, one can determine in nearly every instance which of the three he has in hand. There are many persons who are able to recognize oleomargarine, almost without fail, by taste and smell alone. To those not possessed of this power the boiling test, which is performed with almost no trouble, will serve every needful purpose.

In every instance it is advisable to try the tests on samples of known origin in order to be more certain of the results when samples of unknown origin are used.

Watered Milk.—Nearly all natural water contains a trace of nitric acid as nitrates, and this fact has led to the following test:

Nitrates in milk may be detected as follows: The serum of the milk is prepared by adding 2 parts of 25 percent acetic acid to 100 parts of milk and heating for twenty minutes at a temperature of 160°. If desired, alum may be employed in place of acetic acid. When the milk is evidently coagulated, the beaker is placed in ice water until thoroughly cooled and the clear serum is then separated from the curd by filtering. A few drops of the serum are placed in a white porcelain dish or saucer and 1 or 2 drops of strong sulfuric acid (at least 80 percent) containing 0.1 gram diphenylamin per 100 c.c. is added. The presence of nitrates is indicated by the formation within a minute or two of a deep blue color. If the sulfuric acid is placed in the milk serum without mixing, it will settle through the serum to the bottom and a blue ring will be apparent at the edge of the rim of sulfuric acid. The test is an exceedingly delicate one and blank tests must be made with the reagents employed in order to be sure a trace of nitrate is not obtained with them. Milk known to be free from nitrates should also be employed as a means of testing the reagents. It is our experience that milk giving this diphenylamin reaction for nitrates has always been watered. At the same time, the test has been objected to on the ground that dung dropping from the cow into the bucket during the operation of milking was likely to introduce nitrates into the milk.

Gelatin in Ice Cream.—The method for the detection of gelatin in ice cream is as follows: Fifty parts of the ice cream are treated with 25 parts of water and brought to the boiling point to dissolve any thickener that may be present and not in complete solution. Ten parts of this preparation are treated as follows: Prepare an acid solution of mercuric nitrate by dissolving mercury in twice its weight of nitric acid of 1.42 specific gravity, and diluting this solution to 25 times its bulk with water. To 10 parts of the milk or cream to be examined, add an equal volume of the acid mercuric nitrate solution, shake the mixture, add 20 parts of water, shake again, allow to stand five minutes, and filter. If much gelatin is present the filtrate will be opalescent and can not be obtained quite clear. To a portion of the filtrate contained in a test tube, add an equal volume of a saturated aqueous solution of picric acid. A yellow precipitate will be produced in presence of any considerable amount of gelatin, while smaller amounts will be indicated by a cloudiness. In the absence of gelatin the filtrate obtained will remain perfectly clear.

PART XII.

ACID AND ALKALINE FOODS.

Signification of Terms.—The terms "acid" and "alkaline," applied to foods, have two significations. First, in the ordinary meaning of the word, they represent foods which have an acid or alkaline reaction. All natural foods are either acid, alkaline or neutral to the common tests. The usual method of testing is by litmus paper, a bibulous paper impregnated with the coloring matter of lichens. Litmus paper is of two kinds, a blue and a red. Blue litmus paper will turn red in the presence of an acid. The red litmus paper will turn blue in the presence of an alkali. Thus, having two sets of litmus papers, which can be furnished by any dealer in chemicals, we may easily determine the reaction of our foods.

Kinds of Typical Foods.—In the classification of natural foods there are certain general distinctions which are quite familiar. Fruits are quite universally acid, some of them slightly acid and others decidedly so. The acids which are most abundant in fruits are citric, malic and tartaric. Citric acid is characteristic of the so-called citrous fruits—oranges and lemons. Malic acid is characteristic of apples, peaches, pears, prunes, plums, et cetera; and tartaric acid of grapes. Succulent vegetables are uniformly acid in their reaction, but not nearly so markedly as the fruits. There are some succulent vegetables, such as beets, which are more likely to be alkaline than acid. Cereal foods are usually neutral to the acid or alkaline test. In their natural state they are too dry to give any test at all. Meats and milk are uniformly nearly neutral in their fresh state. Milk on standing rapidly develops, under the influence of a ferment, an acid reaction. The acid in milk is chiefly lactic, though citric acid exists in combination with the minerals of milk in a natural state. To summarize, we may say that fruits and succulent vegetables are generally acid, meats and milk are neutral or slightly alkaline and cereals are generally neutral.

Classification of Foods in Regard to Their Final Reaction After Digestion.—Second from a dietetic point of view foods are classed in respect of reaction which the residues give, that is, the mineral substances which they contain after digestion. This classification is quite different, as a rule, from the natural classification above mentioned. The effects of food on the reaction of the body in general is not by any means the same as the reactions of the foods themselves. The human body, which may be regarded as typical of living bodies, has a peculiar relation to acids and alkalies.

The contents of the stomach are uniformly acid. This acidity is due chiefly to a mineral acid, hydrochloric, which, when combined with soda, forms common salt. The hydrochloric acid which is found in a free state in the stomach is derived chiefly from the common salt which is present in our foods or added thereto for condimental purposes. The presence of hydrochloric acid in the stomach is necessary to the digestion of proteins, the preliminary digestion of which takes place in the stomach.

In general the other parts of the body are either neutral or alkaline. Alkalinity is particularly necessary in the blood, lymph and other tissues of the body. Just as the functions of the stomach cannot take place without acid, so the functions of the blood cannot take place without alkali. Those foods which, upon digestion, leave a mineral residue which is acid in reaction are called acidic foods. Those foods which, upon digestion, leave an ash or mineral substance which is alkaline are called alkaline foods. It so happens that in general acidic and alkaline in the above sense are found in foods which are alkaline and acidic in the first sense. In other words the foods which are naturally acid, such as fruits and vegetables, on digestion leave a mineral residue which is alkaline in its character, and in general those foods which are neutral or alkaline in character in a natural state leave a mineral residue which is acidic in character. This fact is best illustrated by cereals and meats. Lean meats, which are usually alkaline in a natural state, on digestion leave a residue which is acid. This is due particularly to the phosphorus and the sulphur which lean meats contain. During digestion they are oxidized largely into phosphoric acid and sulphuric acid. As soon as the alkaline bodies in the meat, such as lime, soda, potash and iron, are neutralized any excess of phosphoric and sulphuric acids produces an acid reaction. In the case of cereals the same condition obtains. Cereals are particularly rich in phosphorus and the protein of the cereals contains the usual amount of sulphur. On digestion phosphoric acid and sulphuric acid are produced. As soon as the alkaline or basic substances in cereals are neutralized any excess of phosphoric and sulphuric acid produces acidity. In the case of milk, although it contains both phosphoric acid and sulphur, it has so large a proportion of mineral substances, namely, lime, potash and iron, that the final residue is alkaline, because there is an excess of the alkaline bodies in milk.

Importance of an Alkaline Residue in Digestion.—Because of the fact that the great mass of the body is alkaline, and especially the blood, the importance of securing an alkaline residue on digestion of our foods is fundamental. If the blood should lose its alkalinity it would be unable to carry oxygen to the tissues. If the tissues should become acid they of course would draw upon the blood for a part of its alkalinity. The final result would be a diseased condition of the body which is known in medicine as acidosis. In a condition of acidosis the proper functions of the body are impossible of performance, and sickness, abnormality of the tissues and anemia supervene. Not only is it important to have food free of adulteration and debasement, but it is also equally important to so balance it in our rations as to avoid the condition leading to acidosis.

Construction of a Bill of Fare.—In the building of a bill of fare it is no longer sufficient to keep in view only the number of calories which a given portion of a bill of fare will produce. While it is important that the heat-producing power of the food is sufficient for all the activities of the body, it is still more important that the foods should be so combined as to leave the final residue, on combustion in the body, basic in character. The common practice, which is based on sound scientific principles, illustrates this point. It is almost a universal custom to furnish potatoes with roast beef and other similar meats. This is not merely by reason of taste or flavor, but is conditioned by rigid scientific principles of nutrition. Calorie for calorie, the acidic character of the meat consumed (roast beef) is just about balanced by the basic character of the potatoes consumed. Thus if we have in the bill of fare enough meat to furnish three hundred calories, we should have enough potatoes or similar vegetable to furnish the same amount of heat and energy. In making bills of fare there should be kept in view the general principle that all cereals and all lean meats leave an excess of acid on digestion and that all fruits and all vegetables leave an excess of base on digestion. Even rhubarb, which is one of the most acid foods which we eat, gives a basic residue on digestion, and even beans, which contain more protein than almost any other vegetable substance, leave a slightly basic residue on digestion.

It is well to have in mind some of the articles which produce large quantities of acid and base. Lean meat of all kinds is distinctly acidic. The more fat there is in meat, the less acid any given weight of it will be. Some kinds of fish are particularly acidic, more so, even, than beef. Fowls are also very acidic in character, especially when they are not very fat. Cod is one of the fish products which produces an excessive amount of acid. Eggs, also, are quite acidic in character, being quite equal in that respect, if not superior, to lean meat of the same calorific value. Oysters are decidedly acidic in their digestion residues being about three or four times as acidic in character as ordinary lean meat and standing at the head of acid-forming foods.

Among the low acid-forming meat foods may be mentioned the goose, lamb and mutton. These meats have only about one-third to one-half of the acidic properties of beef and fish, and one-tenth of the acidic properties of oysters for equal calorie portions. Cereals are less acid by far than red meats, having only about from one-fourth to one-half as large an acid-forming content. Rice is somewhat less acidic in character than wheat, but a little more acid in character than corn meal.

Among the base-forming substances spinach holds first place. It has long been known that spinach is a wholesome food product. It is recommended even for infants and young children if properly prepared. It does not have a high food value but it does have a high dietetic value, as it tends more than any other one substance commonly eaten to prevent acidosis and correct an acid condition when once established. Among other vegetables of high basic value may be mentioned beets, cabbage, carrots, fresh cucumbers, dried figs, lettuce, onions, parsnips, pineapple, rhubarb and tomatoes. Milk has a basic value a little less, calorie for calorie, than the acid value of cereals. Therefore the free drinking of milk with cereals is important. Melons are quite basic in their character and therefore have value as a corrective food in addition to the calories which they contain. As a rule nuts are almost neutral in their final reaction. This is due principally to the large quantities of protein which they contain. Nuts may be substituted for meats with advantage, as they are nearly neutral while meats are highly acidic. Nuts also are more closely allied to meats chemically than any other vegetable products, as they are composed chiefly of protein and oil. For this reason nuts should not be eaten when meats are served at a meal, but should be reserved for the meatless meals of the day.

How Do Naturally Acid Foods Become Alkaline on Digestion?—It is difficult to explain to a layman why foods which are naturally acid become alkaline on digestion. For instance, the orange and apple are decidedly acid in their reactions. These acids are combined with basic substances, principally potash and lime in fruits. During digestion the organic acids, such as citric and malic, are oxidized to carbonic acid. The carbonic acid combines with the potash, regarding that as the typical base, to form a carbonate or acid carbonate. A carbonate is strongly alkaline in reaction. The common baking soda, or bicarbonate of soda, is a slightly alkaline but nearly neutral body. Both the potash and the soda in our foods, if they are largely fruits and vegetables, are found in the residue of digestion, and it is due to these carbonates and bicarbonates that the alkalinity of the blood and the other tissues is maintained. Thus the fruits, the vegetables and the milk of our dietary result in the formation of carbonates and bicarbonates of the alkalies in the blood and tissues.

The phosphoric acid which is produced during digestion, or which may be naturally present in our foods, combines chiefly with lime, for the nutrition of the bones, the teeth and the other tissues of the body in which phosphate of lime occurs. If, however, the amount of phosphoric acid is in excess of any base which may be formed it becomes free phosphoric acid and combines with any base with which it may come in contact. Fortunately in the well-balanced diet there is quite a sufficiency of basic material not only to form the carbonates and bicarbonates so necessary to our health, but also to neutralize both the phosphoric acid and the sulphuric acid due to metabolism. Hence phosphates and sulphates are constantly excreted from the body, mostly in the urine.

General Principles of Nutrition.—From the above facts it is easy to draw the conclusion that if we are fed cereals alone the end result will be a tendency to acidosis, because the acids produced from the digestion of the cereals are greater in quantity than is necessary to neutralize the bases which the cereals contain. For a like reason a diet composed almost or quite exclusively of meat would soon lead to injurious results, because the acids formed from the digestion of the meat would be greater than the bases which the meat contained. For the same reason, though not to such an extent, a diet consisting of fruits alone, or of succulent vegetables alone, would tend to produce too great a degree of alkalinity in the body and to that extent interfere with the necessary functions of the acid bodies, all of which are highly important.

The sulphur or sulphuric acid which is formed during digestion is necessary to build up the protein tissues of the body. Phosphates are necessary for the bones, teeth, and tissues of the body in general, and hydrochloric acid is essential to the proper functioning of the stomach. The scientific diet, therefore, is one in which all these elements are properly incorporated and in such a way that the end result is a slight alkalinity in the total reaction of the digestive residues. Nature fortunately assumes the task of selecting from this general residue the acid elements necessary to stomach digestion and the alkaline elements necessary to the functioning of the blood and lymph. Fortunately our natural taste, when we have access to various kinds of foods, leads us to select those foods which give the slightly alkaline reaction to the sum of the digestive residues. For this reason man, when left to choice, eats cereals, milk, meats, including eggs, fish and fowl, fruits, nuts and vegetables, and usually in the proportion which secures good dietetic results.

By reason of the above facts it is easy to see that the so-called cults in foods which lead us to eat only one kind of food are not based upon sound dietetic principles. There is only one of the cults of this kind which can lay claim to real consideration. That is the vegetarian theory. The vegetarian theory, however, fails completely when we consider the whole course of life of the human animal. If new-born infants were fed according to the vegetarian theory not one of them would reach maturity. They would all die. Man, in his infancy, is purely an animal-eating animal, milk being an animal food. The saving clause in the vegetarian theory is due to the fact that milk and eggs are usually not excluded therefrom. It is not fair to infer, however, that because the human animal during his first year must have only animal food he should subsequently not eat largely of vegetable substances, including cereals, fruits, nuts, and other commonly called vegetables. The development of the masticatory system and the study of comparative anatomy show that man is an omnivorous animal. It is interesting in this connection to call attention to the fact that purely vegetarian animals, such as the bovine, and purely flesh-eating animals, such as the leonine, all in the beginning eat the same diet, namely, milk.

The Universal Diet.—There is only one food which may be called the universal food, suitable to all living Mammalia, and that is milk. Milk is the only perfect food. Milk is the only one substance on which growth and health may be secured. Milk, therefore, is an article of diet which is not appreciated as it should be by most people. When grown persons become enfeebled and their digestive organs become weakened often a diet of milk serves to restore health and vigor. As a mono-diet milk is the only perfect example.

Basis of Classification.—The basis of classification of foods in regard to their acidic or basic residues on digestion cannot be predicated alone upon the quantity of mineral substances, that is, of ash, which they contain. The classification is based upon the reaction of the ash. The burning of the foods under precautions to preserve all of their mineral substances furnishes a basis of classification. If these mineral residues react strongly alkaline we may regard the food from which they come as an alkaline food in the dietary sense. If, on the other hand, their reaction shows the presence of acid they may be classed as acidic foods from the dietary point of view. If the reaction is neutral they belong neither to one class nor the other. This classification does not in any way show the comparative value of foods for nutritive purposes, but only their value as useful in balancing the diet to secure health and vigor. In the following tables are given lists of foods which are acidic or basic in regard to their dietary residues.

TABLES OF ACIDITY AND ALKALINITY AND FUEL VALUE OF FOODS.

After having acquired a knowledge of foods, their composition and chief adulterations, it is important to know how to utilize them for the nutrition of man. In this chapter I shall not undertake to write a treatise on nutrition but to give only certain tabular matter which will guide the reader in properly selecting and balancing a diet both as respects acidity and alkalinity of its digestive residues and the ability it has of furnishing the heat and energy of the body.

In selecting a diet, it is important first of all to see that sufficient heat and energy making materials are secured. The tabular matter in this chapter exclusive of that relating to the acidity and alkalinity of the residues is taken from my book on nutrition, entitled "Not by Bread Alone," published by the Hearst's International Library Company, New York City, to whose courtesy I owe the privilege of reproducing the matter herein.

TO CONSTRUCT A RATION OF ANY GIVEN NUMBER OF CALORIES.

For a basic ration it is convenient to select one representing 1.000 Calories, one meal for the average active man, so adjusted that one-sixth of the heat units is derived from protein and five-sixths from carbohydrates and fats.

The typical meal does not include soups, coffee, tea, or dessert, since these items are mostly stimulants, or, in the case of sweets, unbalanced food adjuvants which, on the whole, were better omitted. Let us choose a meal consisting of bread, butter, milk, meat, and potatoes. By consulting the tables the following data (whole numbers) are obtained:

TYPICAL MEAL

	Ounces.	Calories
Bread	3	200
Roast beef	3	250
Milk	16	300
Butter	0.5	100
Potatoes	6	150
Total	28.5	1,000

In all cases the quantities refer to the edible portion.

From the percentage of protein in these food products and the quantities used in the ration it is found that the 1.5 ounces of protein in the meal furnished 160 Calories and the carbohydrates and fats 840 Calories. This ration, therefore, has a nutritive ratio of 5. Assuming that the mineral content of the ration which is not included in these calculations is of the right kind and amount, three meals of the above proportions furnish an ideal ration of the average man at moderate work for one day.

INDEX FOR CONVENIENCE IN USING TABLES

Among a multitude of data arranged by groups of like kinds the particular article of diet will be hard to find. The food products, which include most of the kinds commonly consumed, are arranged alphabetically in the following table index.

Meats.

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Calf's Liver	E. P.*	....	....	....	....	....	....	....	....	....
	A. P.	....	73.0	19.0	5.3	....	1,265	575	79.1	2.82
Ham, smoked, lean	E. P.	....	53.5	19.8	20.8	....	2,739	1,245	36.5	1.30
	A. P.	11.5	47.2	17.5	18.5	....	2,431	1,105	41.1	1.47
Ham, smoked, medium fat	E. P.	....	40.3	16.3	38.8	....	4,268	1,940	23.4	0.83
	A. P.	13.6	34.8	14.2	33.4	....	3,685	1,675	27.1	0.97
Ham, smoked, fat	E. P.	....	27.9	14.8	52.3	....	5,467	2,485	18.3	0.65
	A. P.	3.4	25.2	12.4	53.7	....	5,489	2,495	18.2	0.65
Ham, smoked, all analyses	E. P.	....	39.8	16.5	38.8	....	4,279	1,945	23.3	0.83
	A. P.	12.2	35.8	14.5	33.2	....	3,674	1,670	27.2	0.97
Ham, smoked, boiled	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	51.3	20.2	22.4	....	2,904	1,320	34.4	1.23
Ham, boneless, raw	E. P.	....	50.1	14.9	28.5	....	3,256	1,480	30.7	1.09
	A. P.	3.3	48.5	14.3	27.5	....	3,135	1,425	31.9	1.14
Kidneys, Mutton	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	78.7	16.5	3.2	....	968	440	103.3	3.7
Lamb, side, without tallow	E. P.	....	58.2	17.6	23.1	....	2,860	1,300	34.9	1.25
	A. P.	19.3	47.0	14.1	18.7	....	2,321	1,055	43.1	1.54
Lamb, leg, hind, fat	E. P.	....	54.6	18.3	27.4	....	3,289	1,495	30.4	1.09
	A. P	13.4	47.3	15.8	23.7	....	2,849	1,295	35.1	1.25
Lamb, leg, free from all visible fat	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	72.3	25.3	2.7	....	1,287	585	77.7	2.7
Lamb, leg, hind, all analyses	E. P.	....	58.6	18.6	22.6	....	2,860	1,300	34.9	1.25
	A. P.	13.8	50.3	16.0	19.7	....	2,486	1,130	40.2	1.43
Mutton, hind leg, lean	E. P.	....	67.4	19.8	12.4	....	1,958	890	51.1	1.9
	A. P.	16.8	56.1	16.5	10.3	....	1,628	740	61.4	2.91
Mutton, hind leg, fat	E. P.	....	55.0	17.3	27.1	....	3,223	1,465	31.0	1.11
	A. P.	12.4	48.2	15.2	23.8	....	2,838	1,290	35.2	1.26
Mutton, hind leg, all analyses	E. P.	....	63.2	18.7	17.5	....	2,387	1,085	41.9	1.5
	A. P.	17.7	51.9	15.4	14.5	....	1,980	900	50.5	1.8
Ox tail, canned	E. P.	....	67.9	26.3	6.3	....	1,661	755	60.2	2.20
	A. P.	29.7	47.7	18.5	4.5	....	1,177	535	85.0	3.03
Pork, Tenderloin	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	66.5	18.9	13.0	....	1,980	900	50.5	1.8
Sausage, average Pork	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	39.8	13.0	44.2	1.1	4,675	2,125	21.4	0.76

*E. P.: Edible portion. A. P.: As purchased.

MEATS.—(*Continued.*)

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Sweetbreads, beef....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	70.9	16.8	12.1	....	1,815	825	55.1	1.97
Tongue, Beef (Ox)....	E. P.	....	70.8	18.9	9.2	....	1,628	740	61.4	2.2
	A. P.	26.5	51.8	14.1	6.7	....	1,199	545	83.5	2.98
FOWLS AND SEA FOOD.										
Chickens, Broilers....	E. P.	....	74.8	21.5	2.5	....	1,111	505	90.0	3.2
	A. P.	41.6	43.7	12.8	1.4	....	649	295	154.1	5.5
Eggs, Hens'..........	E. P.	....	73.7	13.4	10.5	....	1,584	720	63.1	2.3
	A. P.	11.2	65.5	11.9	9.3	....	1,397	635	71.6	2.55
Fowls...............	E. P.	....	63.7	19.3	16.3	....	2,299	1,045	43.5	1.55
	A. P.	25.9	47.1	31.7	12.3	....	1,705	775	58.7	2.08
Turkey..............	E. P.	....	55.5	21.1	22.9	....	2,992	1,360	33.4	1.2
	A. P.	22.7	42.4	16.1	18.4	....	2,365	1,075	42.3	1.5
Crab meat...........	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	77.1	16.6	2.0	1.2	913	415	109.5	3.91
Crabs, hardshell, whole.............	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	52.4	36.7	7.9	0.9	0.6	429	195	233.1	8.3
Lobsters, whole.......	E. P.	....	79.2	16.4	1.8	0.4	858	390	116.5	4.1
	A. P.	61.7	30.7	5.9	0.7	0.2	308	140	324.7	11.59
Oysters in shell.......	E. P.	....	86.9	6.2	1.2	3.7	517	235	193.4	6.9
	A. P.	81.4	16.1	1.2	0.2	0.7	99	45	1010.1	36.1
Oysters, bulk.........	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	88.3	6.0	1.3	3.3	506	230	197.6	7.06
Scallops.............	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	80.3	14.8	0.1	3.4	759	345	131.8	4.71
VEGETABLES, FRESH.										
Artichokes...........	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	79.5	2.6	0.2	16.7	803	365	124.5	4.45
Asparagus...........	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.0	1.8	0.2	3.3	231	105	432.9	15.4
Beets...............	E. P.	....	87.5	1.6	0.1	9.7	473	215	211.4	7.5
	A. P.	20.0	70.0	1.3	0.1	7.7	374	170	267.4	9.55
Beets, cooked........	E. P.	....	88.6	2.3	0.1	7.4	407	185	245.7	8.8
	A. P.	....	....	....	....	....	....	....	....	....
Beans, String.........	E. P.	....	89.2	2.3	0.3	7.4	429	195	233.1	8.3
	A. P.	7.0	83.0	2.1	0.3	6.9	396	180	252.5	9.02

VEGETABLES, FRESH.—(*Continued.*)

NAME.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Cabbage	E. P.	....	91.5	1.6	0.3	5.6	319	145	313.4	11.2
	A. P.	15.0	77.7	1.4	0.2	4.8	275	125	363.6	12.98
Carrots	E. P.	....	88.2	1.1	0.4	9.3	462	210	216.4	7.7
	A. P.	20.0	70.6	0.9	0.2	7.4	352	160	284.1	10.14
Cauliflower	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	92.3	1.8	0.5	4.7	308	140	324.7	11.59
Celery	E. P.	....	94.5	1.1	0.1	3.3	187	85	534.7	19.1
	A. P.	20.0	75.6	0.9	0.1	2.6	154	70	649.3	23.19
Corn, green	E. P.	....	75.4	3.1	1.1	19.7	1,034	470	96.7	3.4
	A. P.	61.0	29.4	1.2	0.4	7.7	396	180	252.5	9.02
Cucumbers	E. P.	....	95.4	0.8	0.2	3.1	176	80	568.2	20.3
	A. P.	15.0	81.1	0.7	0.2	2.6	154	70	649.3	23.19
Eggplant	E. P.	....	92.9	1.2	0.3	5.1	286	130	349.7	12.48
	A. P.	....	....	....	....	....	....	....	....	....
Leeks	E. P.	....	91.8	1.2	0.5	5.8	330	150	303.0	10.82
	A. P.	15.0	78.0	1.0	0.4	5.0	286	130	349.7	12.48
Lettuce	E. P.	....	94.7	1.2	0.3	2.9	198	90	505.1	18.03
	A. P.	15.0	80.5	1.0	0.2	2.5	165	75	606.1	21.64
Onions	E. P.	....	87.6	1.6	0.3	9.9	495	225	202.0	7.21
	A. P.	10.0	78.9	1.4	0.3	8.9	451	205	221.7	7.92
Parsnips	E. P.	....	83.0	1.6	0.5	13.5	660	300	151.5	5.41
	A. P.	20.0	66.4	1.3	0.4	10.8	528	240	189.4	6.76
Peas, Green	E. P.	....	74.6	7.0	0.5	16.9	1,023	465	97.7	3.49
	A. P.	45.0	40.8	3.6	0.2	9.8	561	255	178.2	6.3
Potatoes	E. P.	....	78.3	2.2	0.1	18.4	847	385	118.1	4.22
	A. P.	20.0	62.6	1.8	0.1	14.7	682	310	146.6	5.2
Potatoes, Sweet	E. P.	....	69.0	1.8	0.7	27.4	1,254	570	79.7	2.85
	A. P.	20.0	55.2	1.4	0.6	21.9	1,012	460	98.8	3.53
Pumpkin	E. P.	....	93.1	1.0	0.1	5.2	264	120	378.8	13.53
	A. P.	5.00	46.5	0.5	0.1	2.6	132	60	757.6	27.05
Radishes	E. P.	....	91.8	1.3	0.1	5.8	297	135	336.7	12.02
	A. P.	30.0	64.3	0.9	0.1	4.0	209	95	478.5	17.08
Rhubarb	E. P.	....	94.4	0.6	0.7	3.6	231	105	432.9	15.5
	A. P.	40.0	56.6	0.4	0.4	2.2	143	65	699.3	24.98

VEGETABLES, FRESH.—(*Continued.*)

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Spinach	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	92.3	2.1	0.3	3.2	242	110	413.2	14.7
Squash	E. P.	....	88.3	1.4	0.5	9.0	473	215	211.4	7.55
	A. P.	50.0	44.2	0.7	0.2	4.5	231	105	432.9	15.4
Tomatoes	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.3	0.9	0.4	3.9	231	105	432.9	14.5
Turnips	E. P.	....	89.6	1.3	0.2	8.1	407	185	245.7	8.8
	A. P.	30.0	62.7	0.9	0.1	5.7	275	125	363.6	12.98

VEGETABLES, CANNED.

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Asparagus	E. P.	*	....	....	....	....	....	....	....	....
	A. P.	....	94.4	1.5	0.1	2.8	187	85	534.8	19.1
Beans, baked	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	68.9	6.9	2.5	19.6	1,320	600	75.8	2.71
Beans, Lima	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	79.5	4.0	0.3	14.6	792	360	126.3	4.5
Beans, String	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	93.7	1.1	0.1	3.8	209	95	478.4	17.1
Beans, Wax	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.6	1.0	0.1	3.1	176	80	568.2	20.3
Beans, Haricots, Verts, average	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	95.2	1.1	0.1	2.5	154	70	649.3	23.2
Beans, Haricots, Flageolets, average	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	81.6	4.6	0.1	12.5	704	320	142.0	5.07
Corn	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	76.1	2.8	1.2	19.0	1,000	455	100.0	3.6
Horseradish	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	86.4	1.4	0.2	10.5	506	230	197.6	7.06
Horseradish, evaporated	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	4.3	11.0	0.8	77.7	3,707	1,685	27.0	0.96
Macédoine, mixed vegetables	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	93.1	1.4	....	4.5	242	110	413.2	14.8
Peas, Green	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	85.3	3.6	0.2	9.8	561	255	178.2	6.3

* In articles which are all edible A. P. and E. P. are synonymous terms.

VEGETABLES, CANNED.—(*Continued.*)

NAME.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Okra	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.4	0.7	0.1	3.6	187	85	534.8	19.1
Pumpkin	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	91.6	0.8	0.2	6.7	330	150	303.0	10.8
Tomatoes	E. P.	....	....	....	....	....	....	....	....	....
	A P.	....	94.0	1.2	0.2	4.0	231	105	432.9	15.4

FRUITS, FRESH.

NAME.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Apples	E. P.	....	84.6	0.4	0.5	14.2	628	290	156.7	5.6
	A. P.	25.0	63.3	0.3	0.3	10.8	484	220	206.6	7.4
Apricots	E. P.	....	85.0	1.1	....	13.4	594	270	168.3	6.01
	A. P.	6.0	79.9	1.0	....	12.6	561	255	178.2	6.4
Bananas	E. P.	....	75.3	1.3	0.6	22.0	1,012	460	98.8	3.53
	A. P.	35.0	48.9	0.8	0.4	14.3	660	300	151.5	5.41
Blackberries	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	86.3	1.3	1.0	10.9	594	270	168.3	6.01
Cherries	E. P.	....	80.9	1.0	0.8	16.7	803	365	124.5	4.45
	A. P.	5.0	76.8	0.9	0.8	15.9	759	345	131.7	4.7
Cranberries	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	88.9	0.4	0.6	9.9	473	215	211.4	7.5
Grapes	E. P.	....	77.4	1.3	1.6	19.2	990	450	101.0	3.61
	A. P.	25.0	58.0	1.0	1.2	14.4	737	335	135.7	4.8
Lemons	E. P	....	89.3	1.0	0.7	8.5	451	205	221.7	7.92
	A. P.	30.0	62.5	0.7	0.5	5.9	319	145	313.5	11.2
Oranges	E. P.	....	86.9	0.8	0.2	11.6	528	240	189.4	6.76
	A. P.	27.0	63.4	0.6	0.1	8.5	374	170	267.4	9.5
Peaches	E. P.	....	89.4	0.7	0.1	9.4	418	190	239.2	8.54
	A. P.	18.0	73.3	0.5	0.1	7.7	341	155	293.2	10.5
Pears	E. P.	....	84.4	0.6	0.5	14.1	649	295	154.1	5.5
	A. P.	10.0	76.0	0.5	0.4	12.7	572	260	174.8	6.2
Plums	E. P.	....	78.4	1.0	....	20.1	869	395	115.1	4.11
	A. P.	5.0	74.5	0.9	....	19.1	814	370	122.8	4.4
Prunes	E. P.	....	79.6	0.9	....	18.9	814	370	122.8	4.39
	A. P.	5.8	75.6	0.7	....	17.4	737	335	135.7	4.8

FRUITS, FRESH.—(*Continued.*)

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Raspberries, red	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	85.8	1.0	....	12.6	561	255	178.2	6.4
Raspberries, black	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	84.1	1.7	1.0	12.6	682	310	146.6	5.2
Strawberries	E. P.	....	90.4	1.0	0.6	7.4	396	180	252.5	9.02
	A. P.	5.0	85.9	0.9	0.6	7.0	385	175	259.7	9.3
Watermelons	E. P.	....	92.4	0.4	0.2	6.7	308	140	324.6	11.6
	A. P.	59.4	37.5	0.2	0.1	2.7	132	60	757.6	27.05

PRESERVED FRUITS.

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Apples, sauce	A. P.	....	61.1	0.2	0.8	37.2	1,606	730	62.3	2.22
Apricots	A. P.	....	81.4	0.9	....	17.3	748	340	133.7	4.7
Blueberries	A. P.	....	85.6	0.6	0.6	12.8	605	275	165.3	5.9
Cherries	A. P.	....	77.2	1.1	0.1	21.1	913	415	109.5	3.9
Figs, stewed	A. P.	....	56.5	1.2	0.3	40.9	1,727	785	57.9	2.07
Marmalade, Orange	A. P.	....	14.5	0.6	0.1	84.5	3,487	1,585	28.7	1.02
Peaches	A. P.	....	88.1	0.7	0.1	10.8	484	220	206.6	7.4
Pears	A. P.	....	81.1	0.3	0.3	18.0	781	355	128.0	4.5
Pineapple	A. P.	....	61.8	0.4	0.7	36.4	1,573	715	63.6	2.27
Prunes, sauce	A. P.	....	76.6	0.5	0.1	22.3	946	430	105.7	3.7
Strawberries, stewed	A. P.	....	74.8	0.7	....	24.0	1,012	460	98.8	3.5

GROCERIES, BREAD, ETC.

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Barley, Pearl	A. P.	....	11.5	8.5	1.1	77.8	3,630	1,650	27.6	1.0
Biscuit, graham crackers	A. P.	....	5.4	10.0	9.4	73.8	4,301	1,955	23.2	0.83
Biscuit meal, cracker meal	A. P.	....	9.2	10.9	6.0	72.9	3,982	1,810	25.1	0.9
Biscuit, saltines	A. P.	....	5.6	10.6	12.7	68.5	4,411	2,005	22.7	0.81
Biscuit, oyster	A. P.	....	4.8	11.3	10.5	70.5	4,323	1,965	23.1	0.83

GROCERIES.—(*Continued.*)

Name.		Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Biscuit, soda crackers	A. P.	....	5.9	9.8	9.1	73.1	4,235	1,925	23.6	0.84
Bread, white all analyses	A. P.	....	35.3	9.2	1.3	53.1	2,673	1,215	37.4	1.34
Bread, Graham	A. P.	....	35.7	8.9	1.8	52.1	2,662	1,210	37.6	1.34
Bread, brown	A. P.	....	43.6	5.4	1.8	47.1	2,310	1,050	43.3	1.54
Butter	A. P.	....	11.0	1.0	85.0	....	7,931	3,605	12.6	0.45
Cake, all analyses, except fruit	A. P.	....	19.9	6.3	9.0	63.3	3,685	1,675	27.1	0.97
Cheese, full cream	A. P.	....	34.2	25.9	33.7	2.4	4,290	1,950	23.3	0.83
Chestnuts, dried	E. P.	....	5.9	10.7	7.0	74.2	4,125	1,875	24.2	0.87
	A. P.	24.0	4.5	8.1	5.3	56.4	3,135	1,425	31.9	1.14
Chestnuts, fresh	E. P.	....	45.0	6.2	5.4	42.1	2,475	1,125	40.4	1.44
	A. P.	16.0	37.8	5.2	4.5	35.4	2,079	945	48.1	1.7
Cocoa	A. P.	....	4.6	21.6	28.9	37.7	5,104	2,320	19.6	0.7
Coconut, prepared	A. P.	....	3.5	6.3	57.4	....	6,875	3,125	14.5	0.52
Cornmeal, granular	A. P.	....	12.5	9.2	1.9	75.4	3,641	1,655	27.5	0.98
Corn starch	A. P.	....	....	....	....	90.0	3,685	1,675	27.1	0.97
Cream, 25 percent butter fat	A. P.	....	63.0	6.0	25.0	6.0	2,805	1,275	35.7	1.27
Cream, 36 percent butter fat	A. P.	....	54.0	4.0	36.0	6.0	3,748	1,704	26.7	0.95
Currants, dried	A. P.	....	17.2	2.4	1.7	74.2	3,289	1,495	30.4	1.1
Figs, dried	A. P.	....	18.8	4.3	0.3	74.2	3,245	1,475	30.8	1.1
Flour, wheat, all analyses	A. P.	....	11.4	10.6	1.1	76.3	3,663	1,665	27.3	0.97
Flour, buckwheat	A. P.	....	13.6	6.4	1.2	77.9	3,564	1,620	28.1	1.0
Gelatine	A. P.	....	13.6	91.4	0.1	....	3,751	1,705	26.7	0.95
Honey	A. P.	....	18.2	0.4	....	81.2	3,344	1,520	29.9	1.07
Ice cream	A. P.	....	64.0	6.0	14.0	16.0	2,182	992	45.8	1.64
Lard, unrefined, average	A. P.	....	4.8	2.2	94.0	....	8,822	4,010	11.3	0.41

GROCERIES.—(*Continued.*)

NAME.	Percent refuse.	Percent water.	Percent protein.	Percent fat.	Percent carbohydrate.	Calories per kilo.	Calories per pound.	Grams per 100 calories.	Ounces per 100 calories.
Lard, refined. . . . . A. P.	....	....	....	100.0	....	9,284	4,220	10.8	0.38
Lobster, canned. . . . . A. P.	....	77.8	18.1	1.1	0.5	858	390	116.6	4.16
Macaroni. . . . . A. P.	....	10.3	13.4	0.9	74.1	3,663	1,665	27.3	0.98
Milk, whole. . . . . A. P.	....	87.0	3.3	4.0	5.0	715	325	139.9	4.99
Mincemeat, commercial. A. P.	....	27.7	6.7	1.4	60.2	2,871	1,305	34.8	1.24
Mincemeat, home-made. . A. P.	....	54.4	4.8	6.7	32.1	2,134	970	46.9	1.67
Molasses, cane. . . . . A. P.	....	25.1	2.4	....	69.3	2,838	1,290	359.2	1.26
Oatmeal. . . . . A. P.	....	7.3	16.1	7.2	67.5	4,092	1,860	24.4	0.87
Olives, green. . . . . E. P.	....	58.0	1.1	27.6	11.6	3,080	1,400	32.4	1.16
Olives, green. . . . . A. P.	27.0	42.3	0.8	20.2	8.5	2,255	1,025	44.3	1.58
Pickles, mixed. . . . . A. P.	....	93.8	1.1	0.4	4.0	242	110	413.2	14.4
Rice. . . . . A. P.	....	12.3	8.0	0.3	79.0	3,586	1,630	27.9	0.99
Rolls, all analyses. . . . . . A. P.	....	29.2	8.9	4.1	56.7	3,069	1,395	32.6	1.16
Sardines, canned. . . . . . E. P.	....	52.3	23.0	19.7	....	2,772	1,260	36.1	1.3
Sardines, canned. . . . . . A. P.	5.0	53.6	23.7	12.1	....	2.090	950	47.8	1.71
Shredded wheat, all analyses. . . . . A. P.	....	9.6	12.1	1.8	75.2	3,740	1,700	26.7	0.95
Soup, Consommé. . . . . . . A. P.	....	96.0	2.5	....	0.4	121	55	826.4	29.51
Soup, Mock Turtle. . . . . . A. P.	....	89.8	5.2	0.9	2.8	407	185	245.7	8.8
Soup, Tomato. . . . . A. P.	....	90.0	1.8	1.1	5.6	407	185	245.7	8.8
Starch, Corn. . . . . A. P.	....	8.0	0.2	0.2	90.0	3,626	1,638	27.6	0.97
Sugar, granulated. . . . . . . A. P.	....	....	....	....	100.0	4,092	1,860	24.4	0.87
Syrup, Maple. . . . . A. P.	....	....	....	....	71.4	2,926	1,330	34.2	1.22
Vermicelli. . . . . A. P.	....	11.0	10.9	2.0	72.0	3,575	1,625	28.0	1.0

TABLES SHOWING RELATIVE NEUTRALITY, ALKALINITY AND ACIDITY OF DIGESTED COMMON FOOD PRODUCTS.

FRUITS AND VEGETABLES.

Minimum Alkalinity.	Medium Alkalinity.	Maximum Alkalinity.
Apples	Apricots	Dried beans
Cranberries	Bananas	Beets
Mushrooms	Fresh string beans	Carrots
Onions	Cabbage	Cucumbers
Fresh peas	Cauliflower	Dates
Pears	Celery	Olives
Pumpkins	Grape juice	Pineapples
Radishes	Lemons and lemon juice	Prunes
Watermelon	Lettuce	Raisins
	Canteloupes	
	Oranges and orange juice	
	Peaches	
	Plums	
	Potatoes	
	Sweet potatoes	
	Tomatoes	
	Turnips	

MEATS, ANIMAL OILS AND FATS AND OTHER PRODUCTS, INCLUDING FISH, FOWL AND GAME.

Acid.	Alkaline.	Neutral.
All lean meats of every description, including fish, fowl and game	Milks of all kinds	All animal fats and oils
Cheese	Cream	Butter
Eggs, both white and yolks	Butter milk	
	Sour milk and artificially soured milk including kumyss	
	Artificially soured milk containing alcohol	
	Junket	
	Milk soured with Bulgarian Bacillus	

VEGETABLE SUBSTANCES WHICH PRODUCE ACIDITY.

All cereal products and their preparations.

NUTS.*

Acid.	Alkaline.	Neutral.
Peanuts and peanut butter	Almonds	Brazil nuts
Walnuts	Chestnuts	Butter nuts
	Coconuts	Hickory nuts
		Pecans
		Pine nuts
		Pistachio nuts

* Probably all nuts are slightly acid in their end reaction. The acidity, however, is extremely small. Nuts have been entered as neutral where no definite statements are made that they are acid. The neutrality of nuts is found in the fact that they contain considerable mineral substances and very large quantities of fat. The slight acidity comes from the sulphur in the protein.

PART XIII.

VITAMINS.

Cause of Scurvy.—It has long been known that certain kinds of foods, such as those carried in former times on board ship where long voyages were contemplated, produce a kind of disease which in general has been called "scurvy." For instance, a diet of bread made from white flour, preserved meats, and the absence of fruits and fresh vegetables, is certain in the course of two or three months to induce a disease of this kind. If a supply of fresh vegetables or fruits can be secured the effects of the disease are counteracted and the patients recover. If access to such foods cannot be had, however, the disease often progresses to a fatal issue. The foods which produce scurvy are called corbutic foods, and those which tend to relieve this disease are called anti-scorbutic foods. Although hundreds of years have elapsed since we have historic references to this disease the real nature of it was not discovered until only a few years ago and the nature of the anti-scorbutic elements, though fairly well understood generally, has not been definitely ascertained even at the present time.

Other Related Diseases.—The development of medical science in the last few years has established a number of diseases related more or less intimately to scurvy in that they are truly dietetic diseases. It is meant by that that they are due to some radical fault in alimentation. These diseases are known as beri-beri, pellagra, and certain forms of neuritis.

Beri-beri.—The introduction of polished rice into the countries where rice was the principal food for the inhabitants was followed by the development of a disease which was particularly prevalent in Japan and other rice-eating countries and which was called by the Japanese "beri-beri." The nature of this disease was for a long time unknown. Its ravages became threatening to the people of Japan and other rice-eating countries and the mortality was extremely high. It was discovered (this by accident) that when rice bran was administered to a patient ill of beri-beri recovery took place. This led the Japanese physicians and dietitians to investigate more thoroughly the conditions surrounding the development of the disease and also to administer to patients suffering from beri-beri a broth made of rice bran. It was found that this broth was a specific and not only stopped the ravages of disease but also supplied the conditions for the recovery of the sick. It was only an easy step from these observations to discover that the polishing of the rice was the cause of this trouble.

Natural (Unpolished) Rice.—Natural rice is the principal food of hundreds of millions of the inhabitants of the earth, especially those living in what we call the Orient, in Japan, China and adjacent countries. Evidently the bran of rice contains some vital or life-giving principle which the body of the rice does not contain. One of the early workers in this problem assumed that the vital principle was a nitrogenous body represented by the chemical term "amin." He therefore gave to it the name of "life amin," that is, "vitamin." Subsequent investigations seem to show that this principle of naming the product is erroneous, that it is more likely a phosphatic than a nitrogenous element, or it may be a combination of both. Nevertheless the term "vitamin" has come into general use, and will probably be retained even if the result of the investigation should finally establish the fact that it is a misnomer.

Vitamins.—We mean by the term "vitamin" the sum of those elements in foods very minute in quantity and yet necessary to nutrition. A remarkable discovery has been made that if a synthetic food be given to an animal, containing all the elements necessary to nourish the animal and in the proper proportions, namely, minerals, proteins, fats and carbohydrates, the animal will cease to grow and will gradually sicken and die. If, now, to this perfect chemical diet a vitamin be added, in proper proportions, the animal will thrive and live. It has thus been discovered that food, in order to be effective, must contain sufficient vitamins to supply the conditions of digestion and assimilation.

There are two distinct forms of vitamins, viz., those soluble in water and those soluble in fats and oils.

What Foods Contain Vitamins?—Investigations which have been made indicate that a vitamin is a vegetable product. It occurs in animal foods, especially in the animal secretion, milk, and probably in other portions of animal foods and is derived from the foods which the animals eat. In the milk it seems to adhere particularly to the butter fat, the protein and sugar of the milk apparently not containing any notable portion of the vitamin element. In cereals, in so far as investigations have extended, the vitamin is found particularly in the bran, that is, the outside covering, and in the germ. That is particularly true of rice, and it is probably true of all the other cereals. Vitamins also are abundant in green plants, especially in cabbage, lettuce, asparagus and other vegetable substances, including particularly potatoes. The distribution of the vitamins in plants other than cereals has not been definitely determined, but it is safe to assume that in the leaves as well as in the seeds and tubers the vitamins are most abundant. In the potato it is apparently true that the vitamins are contained largely in the skins, but undoubtedly permeate the mass of the potato. In meats vitamins are not very abundant, and doubtless whatever amount may be present is due to absorption from the vitamins of the foods which have been eaten. The vitamins are practically absent in polished rice, white flour and refined commercial corn meal, leading to the confirmation of the theory that they exist almost exclusively in the outer coverings of the grains and in the germ. Vitamins are particularly abundant in yeast, from which it may be separated by means of a hydrated silicate (Lloyd's reagent).

Things Hurtful to Vitamins.—In so far as investigations have been reported the two most hurtful things in regard to the vitamins are high temperatures and free alkalies. While high temperatures are harmful to vitamins, if there be an abundance of water present the vitamins are not dangerously impaired by the ordinary processes of cooking. In baking, the external crusts will probably have their vitamins pretty thoroughly destroyed, but the interior of the baked body will still be active in this respect. If baking could be conducted at a lower temperature and for a longer time the vitamins would doubtless be more fully protected. For this reason it appears that cooking in a fireless cooker would be less injurious to the vitamins than cooking in an oven or over a fire.

Effect of Canning.—The effect of canning vegetables and fruits upon their vitamin content has not been worked out. Presumably, however, the same principles would hold good as have just been enunciated. The heating of the vegetables or fruits in order to sterilize them will probably injure to a certain extent their vitamin content, but as there is an abundance of water present in this process there is no reason to believe that the vitamin content is seriously impaired. No definite statement can be made respecting this, however, as it has not been determined experimentally yet just what the damage is, if any.

Mixing with Alkalies.—The mixing of foods with alkaline bodies is very destructive of their vitamin content. Fortunately this is rarely done in the way of cooking. Sometimes alkalies are added to green vegetables in the process of cooking to fix and accentuate their green color. This process, while improving the appearance, is not warranted in view of the fact of the injurious effect of alkalies upon the vitamin content. Better, by far, to cook green vegetables and have them fade somewhat in the process and still remain acid than to render them alkaline and have the green color more perfectly maintained. As a result of investigations which have already been made, the practice of eating our fruits and vegetables in the raw state seems to have received a considerable degree of support. There is some danger in eating fruits and vegetables raw, of course, due to contamination in growing and handling. There is but little doubt of the fact, however, that when eaten raw they are more potent in so far as their vitamin content is concerned than when cooked. Thus, if fruits and vegetables be thoroughly cleaned, they may be eaten raw with benefit. Particularly is this true if it should turn out on further investigations that the vitamin content of fruits and potatoes is largely centered in their skins, as is the case with rice and other cereals. The habit of throwing away the skins of fruits and vegetables is not only wasteful, but may be really detrimental to health in case these conclusions should be warranted by the final results of the investigations. These conclusions, however, do not indicate that cooking is always detrimental. There are many vegetables which are practically inedible raw, among these one of the most valuable of all, the potato. In view of what has been said above in regard to the limited effect of heat in cooking where abundant moisture is supplied, it is safe to conclude that in the proper cooking of vegetables, although their vitamin content may be somewhat diminished, it is not dangerously decreased. Thus those vegetables and fruits which are improved by cooking are not to be excluded from our diet by reason of any slight decrease of vitamin potency.

Practical Applications of the Vitamin Theory.—It is evident that useful lessons respecting the value of foods have been taught by the progress which has been made in the study of vitamins. The whole line of dietary diseases, beginning with scurvy and ending with pellagra, is doubtless largely due to deficiency in the vitamins in our foods. Well-to-do people even, who have abundant choice of their foods, fail to select those which have the proper vitamin and mineral content. Fortunately these two conditions usually go together. Any mechanical process which diminishes the vitamin content of our food also diminishes its mineral content, because the vitamins seem to prefer those portions of our foods which contain the largest quantity of mineral, as, for instance, the bran of cereals and the skins of fruits and vegetables. Thus the demineralizing of foods is also the devitaminizing of foods. Hence we learn to associate the ideas of the vitamin and mineral content, and very properly so.

Waste of Vitamins.—The most striking illustration of the waste of vitamin and mineral utility is found in the common method of milling our cereals and in the peeling of our fruits and vegetables. Both cereals and potatoes are matters of great national and personal interest. In round numbers if may be said that 70 percent of the weight of wheat and other milled cereals appears in the food product, namely, the flour or meal made therefrom, and 30 percent of the wheat and other milled cereals are rejected for human food. This 30 percent contains practically the minerals and vitamins of cereals. Hence the parts of the cereals which are now generally consumed are scorbutic in character, that is, they tend to produce those diseases of which scurvy is a type.

Experiments With Fowls.—Carefully conducted experiments show that white flour and commercial corn meal will not support growth in young animals, such as fowls. On the other hand, feeding the young fowls exclusively on these refined products develops, within about 20 days, a species of neuritis which in about 35 days ends fatally. This happens whether they are fed polished rice, white flour, or commercial corn meal Thus it appears that not only do we throw away 30 percent of our cereal foods, but unfortunately nearly all of their vital principles. The residue which we eat would speedily make an end of us were it not for the fact that we are able, by accident, to get other foods containing vitamins and minerals, sufficient perhaps to nourish us in a poor and incomplete way.

Economic Importance of Knowledge.—The economic importance of knowledge of these conditions can only be estimated, but possibly in a reasonably accurate manner. The illustration may be couched in a concrete form. Apparently the people of the United States consume for domestic purposes, mostly for food but partly for seed, six hundred million bushels of wheat a year. It is evident from the above statement that as far as food at least is concerned four hundred million bushels of wheat, if eaten in the whole state, that is, the whole ground grain, all made into flour, would give the same bulk of nourishment as the six hundred million bushels now used. In addition, however, it would give a food of much higher nutritional value, because the mineral and vitamin content would be preserved. It is true that the protein content of the whole wheat flour is not quite as digestible as the protein of the fine white flour On the whole, however, the total amount of assimilable protein is far greater in the whole wheat product. It is not extravagant, therefore, to say that nearly one-third of the expense of living, in so far as the cost of cereals is concerned, would be saved if cereals were eaten in their whole natural condition with proper grinding and cooking. It is not meant by this that they should not be made into bread, but simply that the whole cereals should be made into bread.

Conservation of Health.—A far greater benefit than the conservation of one-third of our cereals would be effected, however, namely, the health of our people would be immensely benefited. If our cereals were eaten whole the naturally laxative (not cathartic) effects which they produce would tend to eliminate that most pernicious condition which so commonly prevails throughout this country, the condition of constipation. It is acknowledged now by most authorities that constipation tends to the development of poisonous substances in the colon, especially by producing what is known as auto-intoxication, a common cause of premature old age and death.

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